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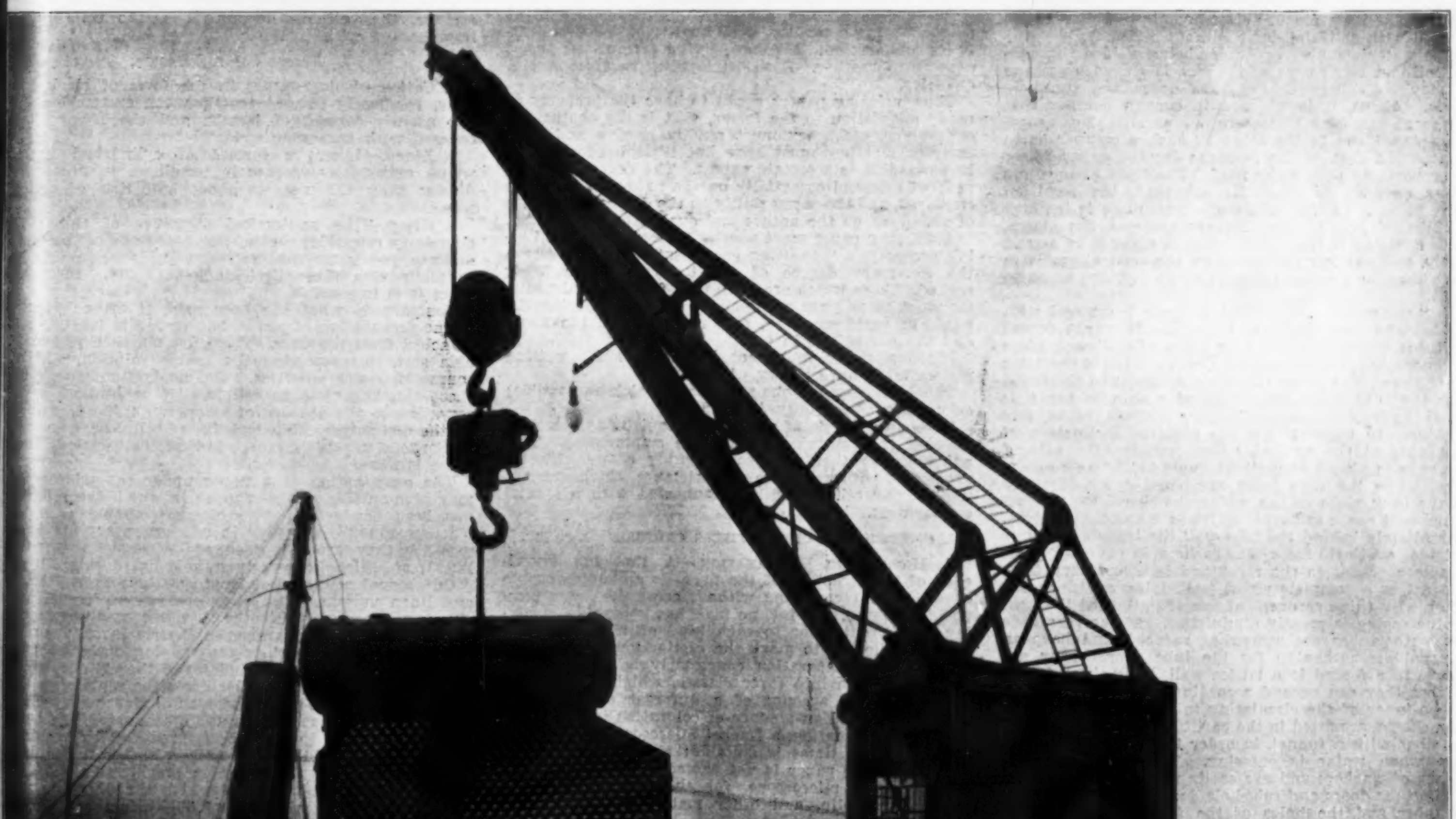
A DÜRR MARINE BOILER.

FIVE DÜRR BOILERS, FORMING PART OF BATTERY OF EIGHT HAVING TOTAL CAPACITY OF 6,370 H. P.



ELECTRICALLY-OPERATED WHARF CRANE LOWERING A MARINE BOILER INTO POSITION.

GERMAN MARINE BOILER CONSTRUCTION.

GERMAN MARINE BOILER CONSTRUCTION.*

By FRANK C. PERKINS.

ONE of the leading marine-boiler manufacturing establishments in Germany is that of the Düsseldorf-Ratinger Rohrenkesselfabrik, formerly Dürr & Co. The accompanying illustrations show the present arrangement of the plant at Ratingen, as well as at Düsseldorf-on-the-Rhine, Germany. In the foreground of one picture may be noted an electrically-operated wharf crane at the Düsseldorf works in the act of placing a marine boiler in position on board a steamer lying alongside the quay. A battery of boilers of 45,176 square feet heating surface and with a capacity of 15,600 horse power is in operation upon the large cruiser "Prinz Heinrich," of the Germany navy, one of which is seen in the accompanying illustration. Fourteen boilers of the Dürr marine type on board the cruiser "Friedrich Karl" of the German navy have a total capacity of 18,000 horse power, and a heating surface of 49,514 square feet. The five boilers noted in one of our pictures are now in operation upon a steamship of the German Line, "Sachsen," the entire battery consisting of eight boilers of 6,370 horse power capacity and 22,712 square feet heating surface.

The Dürr marine boilers are water-tube boilers, and their construction differs considerably from that of land boilers, as more consideration is given to the principal requirements of shipbuilding, regarding space and weight. The water tubes are inclined and closed at their back ends, while their open front ends are joined to a vertical water chamber. One or two steam drums as steam collectors are placed upon the water chamber. A superheater, constructed of circulating tubes, is connected with the steam collector or with the upper part of the water chamber. The furnace is placed below the tubes, which are generally inclosed with a casing of sheet iron.

The principle of the separation of steam and water circulation is carried out in the Dürr marine boiler. The water chamber possesses a vertical partition wall in which feeding or inner circulating tubes are fitted. By this arrangement a circulation of the boiler water is obtained. The water, heated and evaporated in the water tubes and following the ascendant direction of the tubes, enters the back part of the water chamber and rises to the steam drum, where the steam is collected. From the steam drum the water falls down to the front part of the water chamber, and, mixed with fresh feed water, it is forced to travel through the inner tubes to the water tubes, replacing the heated or evaporated water. By this circulation the current of steam, traveling upward, is kept separate from the feed water, traveling downward. As all these passages of water and steam are of large area, a quick and uniform circulation of the boiler water is insured, even if the boilers are forced to the extreme. On the other hand, the construction of only one water chamber allows the water tubes to expand, freely and independently, so that leakages on account of expansion are absolutely avoided, allowing the boiler to be worked with artificial draft without difficulty.

The water chamber or header being welded throughout without any seams and rivets, is stayed by means of stay bolts between the tube doors and tube-hole doors. Above, it is widened in such a manner that the front and back plates are not parallel, but wedge-like, placed one to the other in such a manner as to enlarge the area of the passages for the rising water in proportion to the water used. The front plate of the water chamber is vertically arranged, the partition plate parallel to this, while the back plate is inclined slightly backward. By this arrangement the steam, after having left the water tubes, is allowed to ascend freely, and has less resistance on the vertical partition plate than in a water chamber of an inclined arrangement.

The water tubes are fitted at their front end with welded and conically-turned bands. They are forced by these bands into the tube holes of the back plate of the water chamber, which holes are bored to the same taper gage. The water tubes are pressed and tightened into the tube holes by means of a spindle press or small hydraulic pressure pump, without using any packing. In order to get the required inclination of the tubes at the vertical water chamber, the axis of the cone is placed at a slight angle to the axis of the tube, while the tube holes are bored perpendicularly to the back plate of the water chamber. By this arrangement space is saved, which is a valuable feature. Immediately behind the tube wall the tubes of the two outside vertical rows at each side of the tube bundle are bent to the right and left, and they form and act as a complete water wall, lying one upon the other. By this arrangement the radiation of the heat by the casing is greatly diminished. At the rear ends the water tubes are somewhat reduced, and have an internal strengthening for the tube door. They are placed in a forged iron lattice wall, lying there freely, so that they can expand according to the heat.

The inner of the circulating tubes, folded from thin iron sheets, are fitted in the partition plate of the water chamber with a funnel, in order to avoid any contraction when water is entering. They are joined by means of washers and are easily removed.

The tube doors and tube-hole doors for the back ends of tubes and the holes of the front plate of water chamber are inner closures. They are made from forged iron in such a way that they meet the conical tube holes without any packing material, such as copper or rubber. As the closures are to be put inside, they are pressed into their position by the water and steam pressure. For screwing, they are provided with a screw plug, forged upon them. A cap covering the tube hole is put outside over this plug, and then the door screwed on by means of a nut. In order that the doors join more closely to the tube holes, they are hollow and not solid. At their cone end they have a small rim, equal to the conical band of tubes, preventing a drawing through of the closure. In the event of requiring a more frequent change of water, and to make it possible to empty the tubes quickly, the tube doors are constructed in the form of a nut cap. The cap nuts are joined without any packing, by edges turned to the ring, with which the tubes are lying in the lattice wall.

The steam drum is either laid crossways, and connected at its full length with the water chamber, or is fitted lengthways to the water chamber in the direction of the water tubes. The first arrangement with cross-lying steam drum is generally used in ships of the navy, where the conditions require a saving of space and weight. The second arrangement, with the steam drum lengthways, is especially employed on river steamers, on which jet condensers are used, and offers the advantage of forming a kind of mud collector in the back part of the steam drum.

The superheater is placed inside the boiler itself, and cannot be put out of use. Therefore the tubes of the superheater are always cooled by the steam passing through. With boilers having cross-lying steam drum, the superheater tubes are put into the steam drum's wall, and in boilers with steam drum lying lengthways, they are placed in the back plate of the water chamber. In both cases the superheater tubes are laid horizontally lengthwise of the boiler, and fitted into the boiler plate with the same cone as the water tubes. A chamber with partition plate and inner tubes allows the circulation of steam in the same manner as that of the boiler water through the water tubes and their inner tubes.

The steam is taken from the steam drum by a perforated pipe, placed lengthwise of the steam drum. With highly forced boilers, a system of rebounding angles is fixed before this pipe in order to separate particles of water, if any are carried over.

The furnace is specially designed according to the fuel used, and to the degree of forcing necessary. The grate surface and size of furnace bars are chosen accordingly. The grate generally takes all the space lying below the tubes. The area of combustion is surrounded by brickwork from the grate to the tubes.

In cases where the combustion must be as smokeless as possible, a funnel is provided in the lower part of the tubes, by leaving a greater space between the second and third rows of tubes. Those rows of tubes, lying below the funnel, may then receive a little more inclination than the upper rows, in order to widen the funnel. The highest row of the lower part of the tube bundle is covered by fire-bricks in front for two-thirds of its length, and the lowest row of the upper tube bundle on the rear, two-thirds of its length. By this arrangement, the fire is drawn over the grate to the back.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

ANALYSES AND TESTS OF PAPER.*

THE chemistry of paper, or rather the chemical study of paper from a practical standpoint, is quite a new science, but a few years old. In 1891 the German government, convinced of the utility of such a study, founded the royal bureau for the analysis of Berlin papers—an example which was soon followed by the Paris Chamber of Commerce.

Paper, like all manufacturers' products, is sold at prices varying according to its quality, and consequently its composition. A paper serving for one use is not adapted to another. Each employment requires special qualities.

Thus, printing papers ought to have the property of ready adaptation to the forms, that is the characters, engravings, etc., they must readily receive and keep their color; they must have but little hardness, and be permeable to a certain extent. The degree of hardness will depend essentially on the nature of the pulp employed, and the permeability on the degree or absence of sizing, or on the nature and quality of the loading.

A filtering paper must possess, along with the filtering property, a separating power sufficient to preserve the necessary degree of solidity even after being soaked. Those which are to be used for chemical analysis must be as pure as possible. These properties depend, in great measure, on the nature of the fibers and the percentage in ash.

Blotting paper must not be sized, while writing papers must have plenty of size.

Paper for cheap books must be as thick as possible; only moderate solidity is needful.

Thus an analysis of a paper is requisite to ascertain whether it is suitable for a given employment. This analysis is rather a thorough study of its different properties with reference to resistance, thickness, sizing, or any other condition connected with a special employment.

I. INVESTIGATION OF THE FIBERS COMPOSING A PAPER.

A. MICROSCOPIC EXAMINATION.—A thorough knowledge of the structure of the fibers is an indispensable condition in recognizing without error the fibers composing a paper. So far, no plan has succeeded in giving a different color to each kind of fiber and thus enabling the eye to mark the distinction.

However, a separation can nearly be made by an iodized solution into three classes, which the eye can distinguish, on account of a different coloration of two of them and an absence of coloration in the third. For this examination, a Nachet microscope magnifying three hundred times is suitable; this power is quite sufficient. The paper is not passed immediately, as it is, under the microscope, for the fibers are loaded with size, kaolin, and other matters which conceal the form.

An average sample of the paper, reduced to small fragments, in water, is boiled with a small quantity of a 2 per cent solution of soda. After boiling for a quarter of an hour, it is washed by decantation, to the complete elimination of the soda. Then the paper mass, with a slight addition of water, is reduced in an agate mortar to a pulp as homogeneous as possible, until all lumps have disappeared. A small quantity is deposited on a well-cleaned slab with a drop of iodine solution. This solution is composed of water, 20 grammes; iodine, 1.15 grammes; potassium iodide, 2 grammes; glycerine, 1 cubic centimeter. The preparation is covered with a plate of glass, and, on examination, the following classification can be made: 1. Fiber colored yellowish red: (a) wood pulp prepared mechanically; (b) jute. 2. Uncolored fibers: cellulose of (a) straw; (b) wood; (c) esparto. 3. Fibers colored brown: (a) cotton; (b) linen; (c) hemp.

We recommend the agate mortar, in order to avoid errors of analysis due to the previous presence of remains of rags which have been used to clean the mortar, and which are invisible in a porcelain mortar. It is essential to render the paper pulp quite homogeneous, for there is scarcely anything but the microscopic examination at command for the quantitative determination of the different component fibers. It is suitable, therefore, to have a preparation representing exactly the average composition of the paper.

1. *Fibers Colored Yellow.*

a. *Wood Prepared Mechanically.*—This pulp is recognized by the special configuration of the torn extremities of the fibers, and from the fact that the latter, which are rarely separated, are usually more or less agglomerated in small parcels. We have also a more rapid and sure chemical method of determination, which we will examine further on.

b. *Jute.*—The characteristic property of the fibers of the liber of this plant is the varying thickness of the walls of the cells in different places, often from one extreme to another, in the field of the microscope. It also often happens that in the image the fibers are seen collected in a single bundle.

2. *Uncolored Fibers.*

a. *Wood Cellulose.*—The fibers of chemically prepared wood are flat, of ribbon form, presenting unbroken extremities. If cellulose is of resinous wood, there will be noticed on the septum constituting the cell, a succession of open places of circular form presenting the lace appearance commonly called *passe partout.*

The fibers of folious wood do not offer characteristics so distinct and so easily recognizable as those of resinous wood. The bands are much larger and have a small number of pores on the contour, clear-cut and of almond form. The characteristic cells of folious wood are filled with pores presenting the appearance of a sieve.

b. *Alfa Cellulose.*—In general the structure of this cellulose is more delicate and of smaller dimensions than that of straw. The fibers are short, cylindrical, of uniform diameter, with a narrow central canal and rounded extremities, truncated or bifurcated. Besides fibro-vascular bundles of these fibers, there are in alfa, as also in straw, a certain number of cuticular cells, with extremely characteristic dentated contour.

c. *Straw Cellulose.*—In its microscopic characteristics, this pulp much resembles alfa, but its elements are of larger dimensions. There are also found in straw numerous flat and oval cells, quite important in distinguishing straw from alfa, which is completely devoid of these cells.

With cellulose imperfectly prepared, the fibers, which ought to appear colorless in the iodine solution, present a light brownish yellow coloration. The cause is that, in consequence of defective or careless manufacture, the cellulose is not pure, the cells being impregnated with lignine.

3. *Fibers Colored Brown.*

a. *Cotton.*—This appears in the form of black ribbons, frequently twisted together, the extremities being usually formed of lamels, and the fibers often covered with numerous striæ.

b. *Linen.*—Linen is formed of cylindrical fibers, whose extremities frequently terminate in numerous fibrils; their thickness is about half that of cotton fibers.

c. *Hemp.*—The anatomical structure of this fiber singularly resembles that of linen, and one of the most delicate points in the microscopical examination is to distinguish these two kinds of fibers. In many cases it is impossible.

Contrary to what has been said, it often happens in the preparation of paper that very thin lamellæ are detached from the fiber. These are not then in a suitable state for receiving the iodine solution, and of course they are colorless. The analyst may suppose these membranes to be cellulose, if he limits his observation to the absence of color, but if he is guided by the distinctive characteristics of cellulose, he must, in the total absence of these indications, conclude that there is none.

The examination of a paper under the microscope may give an idea of the manner in which the refining has been conducted. The observer should consider whether the fibers appear in a fragmentary state, or whether they are composed of entire cells (of the liber), of which he perceives the pointed extremities.

On account of the great length of their fibers, cotton and linen present, when they are refined fragments, showing at what point the fracture was produced. According to the appearance of the fracture, it is possible to ascertain whether the refining operation was suitably performed. If the plates of the cylinder were too sharp, or if they were let down too rapidly on the plate, the fractures will appear as distinct cuts, while, if the operation has been suitably conducted, the fracture will appear to have been produced by tearing. The importance of this fact, with reference to the ultimate resistance of the paper, is considerable.

Alfa, straw, and wood (of which the fibers do not exceed one or two millimeters) ought, in the majority of cases, to be in the state of complete cortical fibers, with their two extremities pointed. The refining, when it is conveniently conducted, ought to be limited to the separation of these fibers.

B. CHEMICAL INVESTIGATION.—There is a fiber which can be recognized immediately by chemical process. This constitutes the pulp of wood prepared mechanically. It is known that the lignified tissues of the family of the angiosperms are incrusted with the substance called lignine; the principal component of lignine is a gum called xylane which, under the action of hydrochloric acid, fixes water and is converted into sugar, a pentose having the name xylose. This, like the pentoses in general, has the property of coloring red a solution of phloroglucine in alcohol. It will be sufficient, therefore, after having treated the paper with hydrochloric acid, for converting the xylane into xylose, to deposit a few drops in a solution of phloroglucine in alcohol. Practically, these

* From the French of M. Eugène Pettigont, Engineer-Chemist, in the Revue de Chimie Industrielle.

two operations are conducted as one. A solution is formed of phloroglucine, 2 grammes; alcohol, 25 cubic centimeters; concentrated hydrochloric acid, 5 grammes. A drop of this solution is put on the paper to be examined, and, in a few minutes, a red coloration appears, more or less intense according as there is more or less of the mechanically prepared pulp in the paper examined. With practice, the exact percentage may be determined according to the coloration. This method is therefore both qualitative and quantitative, and at the same time very rapid; but for a chemist not having often occasion to analyze paper, it is preferable to employ the following method, so far as the quantitative analysis is concerned.

This process consists in treating the paper, hot, with the cupro-potassic liquor. The pure cellulose is easily dissolved, while the cellulose of the mechanically prepared wood, which is impregnated with lignine, remains insoluble. It is sufficient, therefore, to weigh this residue, in order to analyze and subtract from the weight the percentage of loading, which we will speak of hereafter.

Care should be taken not to confound the red coloration obtained with phloroglucine and the pulp of wood prepared mechanically, with that which is yielded by certain colorants of paper, in particular by yellow colorants which become red under the action of hydrochloric acid.

The indispensable microscopic examination will confirm the test by means of phloroglucine.

A new reagent has been lately recommended for the pulp of mechanical wood, which gives to the paper a coloration ranging from light blue to deep violet. This reagent is obtained by boiling on the water bath equal quantities of sulphuric acid and amylic alcohol until reddish yellow vapors are disengaged. But the results furnished by the reagent are far from being as satisfactory as those obtained with phloroglucine.

For the chemical identification of the fibers in writing and printing papers, the reaction, which with phloroglucine is the most useful, is that obtained by means of a solution of aniline sulphate. The fibers (celluloses) of the rag and wood group, do not furnish a reaction, but the celluloses of straw and alfa and the pulp of mechanical wood may be recognized by means of this solution.

If a paper containing straw or alfa is treated for some time with a 1 per cent solution of aniline sulphate boiling, a red color is produced. Alfa furnishes this reaction with more intensity than straw. In this way the presence of a small quantity of these pulps may be discovered with certainty. As the celluloses of alfa and of straw yield on boiling with hydrochloric acid, of the density 1.06, large quantities of furfurol, a determination of this body gives approximatively the proportion of these celluloses in a paper containing, besides those of alfa and of straw, only celluloses of linen and cotton. The proportion in hundredths is obtained by multiplying the number expressing the quantity of furfurol by 8.

If the pulp of mechanically prepared wood is treated with a solution of aniline sulphate, even cold, a deep yellow color is developed. If a paper containing this pulp thus treated, is examined under the microscope, the fragments of the wood are seen to assume a deep color, while the other fibers remain colorless or nearly so.

From the results of the analysis of paper with reference to the fibers composing it, it may be immediately seen whether it is suitable for the purpose designed.

Ordinary printing papers are composed of bisulphitic cellulose and mechanically prepared wood. The cellulose of the birch furnishes a paper very white, but not solid and extendible. It is employed only in countries where other species are lacking, notably those that are resinous.

Beautiful English writing papers are manufactured from alfa containing no trace of mechanically prepared wood. The cellulose of cotton is employed especially for making fine printing papers, which, as we know, ought to be rather soft.

The cells of the liber of flax yield to the paper industry the most perfect crude product, but also the dearest. It is used for manufacturing the finest papers.

Of all the raw materials generally employed for paper, the fibers of hemp are the most resistant, and consequently they are perfectly suitable for papers where great solidity is required, as for documents and banknotes.

II. DETERMINATION OF THE PERCENTAGE IN ASH.

The loading of papers is a matter for consideration in determining their commercial value. It is usual, except in the case of very superior papers, to add to the pulp a certain quantity of some heavy, mineral substance, of comparatively low price, such as kaolin, or for certain qualities, artificial sulphate of lime.

The addition of this loading in moderate quantity can scarcely be considered an adulteration, since it serves for filling the pores of the paper, and yields a closer texture, having a smoother surface and better absorbing the printing ink, at the same time that it allows of giving to the paper a finer surface in the subsequent operations of calendering. It thus increases the opacity, which is a very important point for papers designed for the printing of books. It also enables a manufacturer to satisfy the demand for cheap papers with some chance of remuneration. If added in large quantity, it tends to weaken the paper.

The loading is found in the ash, or the constituent parts of the paper remaining unconsumed after combustion and calcination of the black residue. The ash consists of mineral substances, which, in addition to the loading, may proceed from two sources; first, from the raw material employed in the manufacture (rags, cellulose, wood pulp, etc.), then from materials employed in the sizing, which are especially formed of aluminium resinate.

The cells of plants always contain, even in the purest state, small quantities of mineral substances; lime and silica forming the largest proportion. The size yields a larger proportion of incombustible matter, for in the sizing of paper with the resinate of alumina the work is always performed with an excess of alum or of sulphate of alumina; thus there enters into the paper a certain quantity in excess of the derivatives of alumina, which remain in the ash in the state of alumina (Al^2O^3) and may in certain cases amount to as much as two per cent of the paper. A sized paper may, therefore, in addition to the loading, have a proportion of three per cent in the ash.

The loading is composed principally of kaolin, natural sulphate of baryta, sulphate of baryta manufactured industrially, and sulphate of lime.

The method employed for determining the quantity of ash in a paper is extremely simple. A gramme of the paper is weighed in a platinum dish and burned to a white ash, then weighed anew. From the weight of the paper and the residue, it is easy to deduce the percentage in ash. In order to operate more readily, ash-weighing balances have been constructed, having a hand moving on a graduated dial. After adjusting the balance so that the hand shall stand at zero, 1 gramme of paper is placed in the basin, which has a sheath of platinum cloth. This sheath is introduced in the flame of a gas burner and the contents incinerated. The sheath is afterward brought back on the balance, and the hand gives the figure in centigrammes, indicating in hundredths the percentage of ash in the paper. This method, although generally employed in practice, is quite insufficient for precise results, because the weight of cinder not entirely consumed is counted as ash. Besides, when the paper is incinerated, there is produced, in consequence of the calcination, chemical modifications, more or less profound, in the mineral loading. The elements are driven off or partially converted into other combinations. Thus, for example, suppose that carbonate of lime has been added to a pulp; this on calcination is decomposed into calcium oxide and carbonic anhydride, a reaction which of course occurs when lime is calcined in lime kilns.

To avoid the errors due either to the separation of carbonic anhydride or to the volatility of the chlorides, which may compose the mineral constituent of a paper, M. Ernest Favier proposes sulphuric calcination. For this purpose one gramme of paper, cut into small fragments, is weighed exactly in a porcelain dish. A few drops of sulphuric acid are added, and the whole heated slightly. When the mass, which swells up, is completely black, it may be incinerated. A homogeneous mass is thus obtained, whose weight for a given paper cannot vary with the duration of the incineration and the temperature at which it is effected.

But for a very exact determination of the ash, it is necessary to proceed to a quantitative analysis, preceded of course by a qualitative analysis. The ash proceeding from a paper containing kaolin is insoluble in dilute hydrochloric acid at the boiling point; that proceeding from a paper containing sulphate of lime is soluble. Dissolution deposits on cooling long crystals in the form of needles, and yields, with barium chloride, an abundant precipitate of barium sulphate insoluble in acids; with ammonia and ammoniacal oxalate, a precipitate of oxalate of lime is obtained from the solution. For determining the barium sulphate in the ash, it is fused with a mixture of carbonate of soda and potash. The mass is then dissolved in boiling water. When the qualitative analysis is completed, the quantitative analysis can be conducted by the ordinary processes.

III. EXAMINATION OF THE SIZING.

If refined celluloses are simply put together in leaves, the product obtained will be a blotting or spongy paper. Papers of this class have a well-known use, and are made with the pulps of cellulose to which a small quantity of fecula has been added, which serves to give a certain union to the fibers. Without speaking of the absorbent properties, the papers of this class are soft and have but little resistance; they are altogether unsuitable for rough usage.

Writing papers, on the contrary, have a texture and feel totally different, and present a certain resistance to water and ink; that is to say, they must oppose as little resistance as possible to the mechanical action of writing, but resist the penetration of the ink in such a manner that the characters of the writing may penetrate into the substance of the paper in a single direction, that is perpendicularly to the surface.

These properties are increased in a large measure by means of the sizing, which may be considered in two respects, (1) detection of the size employed; (2) determination of the degree of sizing.

1. *Detection of the Size.*—This may be animal size or resin size (resinate of alumina) or starch.

a. The determination of animal size rests on the property which it possesses of bringing, at the boiling point, the yellow oxide of mercury to the state of metallic mercury, a property lacking in vegetable size and starch.

To make this determination, an excess of caustic soda is poured into a solution of mercury chloride, producing a precipitate of mercury oxide of a beautiful yellow. The supernatant liquor is decanted, and to the oxide of mercury is added the aqueous residue obtained by boiling for a quarter of an hour in distilled water two sheets of the paper to be analyzed, cut up into small pieces. The whole is boiled, and after a certain time a black precipitate is deposited. This is collected on a filter and washed first with pure water, then with dilute hydrochloric acid. If there is no animal size in the paper, the precipitate is entirely dissolved by the hydrochloric acid, while a black residue of metallic mercury remains on the paper, if the paper was sized with gelatine.

If a very small quantity of animal size is to be sought for, and if little paper is at disposal, recourse is had to another process, in which the Miller reagent is employed. This is prepared by mixing a certain weight of metallic mercury with the same weight of fuming nitric acid, and leaving at repose in a cool place for a few hours. An equal quantity of distilled water is then added, and the whole left at rest for twenty-four hours. This reagent preserves its action only for a few weeks, and has the property of coloring red, paper sized with gelatine. It does not act on the gelatine itself, but on the albumen contained. It is well to slightly heat the leaf, on which a few drops of the reagent have been deposited.

b. To recognize whether a paper has been sized with the resinate of alumina, on half a sheet of the sample paper, reduced to very small fragments, absolute alcohol is poured, and the receiver containing the whole is put into hot water for about thirty minutes. If the hot residue is poured into a receiver containing distilled water in sufficient quantity, the resin will be separated; the dilute alcohol cannot retain it in solution.

If the quantity of resin contained in a paper is to be ascertained, a certain quantity of the paper is heated to about 75 deg. C. in a four or five per cent solution of soda, thus forming a soluble resinous soap. It is filtered, washed with hot water, and an excess of sulphuric acid poured on the filtered liquid. The soap is decomposed, filtered, and the resin weighed.

c. The presence of starch is determined by means of an iodine solution. If a drop is deposited on the paper, it assumes a blue coloration in consequence of the formation of starch iodide. A very weak solution of the iodine must be employed.

2. *Determination of the Degree of Sizing.*—Several methods have been proposed for determining this, but they are all substantially represented by the following process: On one side of a sheet trace a series of marks with a neutral solution of ferric chloride by means of an instrument not too hard and having a round point. When the marks are dry, a certain quantity of tannin solution is poured on the back of the paper perpendicularly to the first marks. If the paper is badly sized, the marks traced with the iron perchloride pass through the paper, and the solution of tannin, poured on the back, meets with a small quantity of the iron salt and produces a black coloration of the marks, in consequence of the formation of ferric tannate.

The preceding method has been improved, and the principle of the new process consists in flowing three times successively over the sheet, inclined at 60 deg., a solution composed of perchloride of iron, 1 gramme; water, 100 cubic centimeters; gum arabic, 1 gramme; phenol, 1.2 gramme. After drying the moistened slips, the operation is repeated on the other side with a tannin solution (1 per cent and 0.2 gramme of phenol) in such a way that the bands thus obtained cross with those of the iron solution. In places where the tannin is met by the iron salt, ferric tannate is formed, which is black. According to the time that this coloration takes in forming, the papers are classed as solidly sized, non-solidly sized, and very solidly sized. A special arrangement allows of tracing each line with the same quantity of solution.

Very often in practice the simple test with the pen dipped in ink is sufficient to give an idea of the degree of sizing of the paper.

IV. DETECTION OF CHLORINE AND ACID IN THE FREE STATE.

The alum employed for the sizing of paper with resinate of alumina often contains three acids, and these, attacking the fiber, produce disaggregation. Also, the chlorine which has served for bleaching may not be completely eliminated and produce the same effect. It is important to ascertain whether the paper is free from these substances, especially if it is to be preserved for a long time.

For the detection of chlorine, this is the best process: The paper is cut up in pieces, treated with distilled water, and the pieces placed on each other alternating with potassium iodide starched paper. A plate of glass is placed lightly on the whole, and it is left at rest for about an hour. The water draws off the chlorine, the chlorated water acts on the starched paper, and then a less or greater number of blue spots are produced.

The reagent allowing of the detection of free acids in a finished paper is Congo red. For employing this reagent in a convenient form the filtered paper is colored with a dilute and boiling aqueous solution of Congo red, and the coloring matter adhering mechanically, is removed by a long washing with water. The paper to be tested is thus prepared and placed in a glass receiver with distilled water, and a piece of the Congo paper thrown into the liquor. A blue coloration will attest the presence of free acids. This reaction is extremely sensitive and allows of detecting a quantity of acid of 0.002 per cent.

V. DETECTION OF THE COLORING MATTER.

Quite a delicate problem, frequently impossible to solve, consists in the search for the coloring matter of colored papers. These matters may be divided into three groups, which we give in the following table:

Colorants	Mineral	Soluble tinctures	Coal-tar colors
Blues	ultramarines smalts Prussian blue	tincture of Campeachy wood	soluble blue methylated violet indulines nigrosines methylene blue
Reds	ochres	tincture of cochineal alizarine	rosanilines (magentas) safranines benzo-purpurine eosines
Yellows	chromate of lead mixture of Prussian blue and chromate of lead		auramine naphtol yellow premuline tropeolines chrysoidines malachite green acid green
Browns	ochres	catechu	Bismarck brown

We can at the outset divide these matters into two groups, according as they are soluble or not soluble in water. A sample of the paper is boiled in water, and if the colorant is dissolved, there are two conditions to be considered. In the case of a mineral colorant the operation is simple; it is sufficient to analyze the liquid; but the case is not the same with an organic colorant. In this case the following is the best course:

The aqueous solution is evaporated dry, in order to obtain the product in powder; then follow three

reactions:* (1) dissolution in concentrated sulphuric acid; a coloration ensues, which is generally changed by the addition of water; (2) dissolution in water, with the addition of a few drops of hydrochloric acid; a new coloration is observed; (3) dissolution in water, with the addition of soda; very often a colored precipitate is formed.

The combination of these three colored reactions is generally sufficient to detect the coloring matter.

If the colorant is insoluble, mineral pigments will be obtained in the ash, in certain cases without chemical change (smalts, ferric oxides, etc.). In other cases the original pigments will be in characteristic form, while again the organic colorant will be difficult to distinguish, and the reactions must be determined on the paper itself.

VI. DETERMINATION OF THE RUPTURE LENGTH AND THE LENGTHENING.

By "rupture length" is understood the length of a strip of paper of any width and thickness, which would be reached by the strip suspended at one end under its own weight, and breaking at the point of suspension. This length is generally expressed in kilometers. There are several pieces of apparatus designed to determine the rupture length, but all are constructed on the same principle; they are dynamometers, which differ from each other by the method employed to subject the strip of paper to traction. The most convenient dimensions for this strip have been found to be 0.015 meter in width and 0.18 meter in length. This band is held at each extremity by a clamp and the two clamps are separated from each other by means varying according to the kind of apparatus employed. It follows that the band of paper undergoes traction, and when this is sufficient, the paper breaks. A hand fixed to the apparatus gives the rupture load; the lengthening is determined by the increase in the separation of the clamps.

The rupture length is now to be calculated. Suppose that the test has shown that the average weight of a strip of paper of 18 centimeters is p; we must, according to the definition of the rupture length, calculate what length of the strip of paper of the same width is equivalent to a weight P (rupture load).

Let x be this length; we have $\frac{0.18}{p} = \frac{x}{P}$; whence $x = \frac{0.18}{p} \times P$. $\frac{0.18}{p}$ is called the number of the strength of a paper.

The result x allows of comparing all papers together with reference to their solidity, for it is independent of the width and thickness of the sample.

RESISTANCE TO RUMPLING.

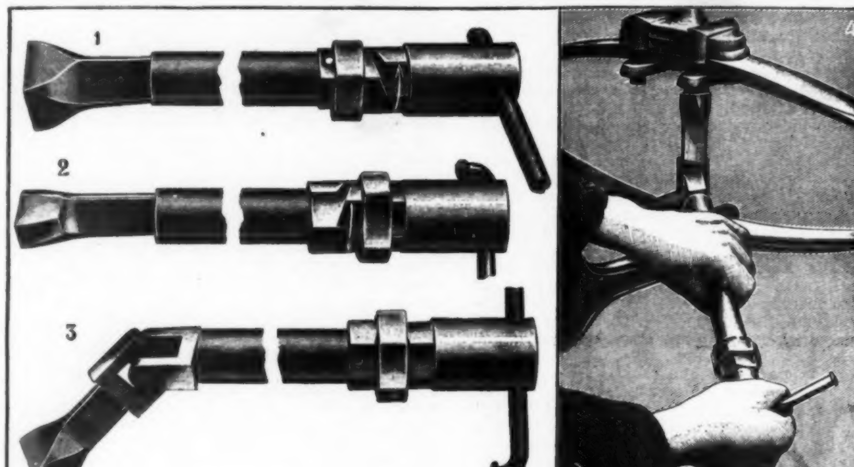
There is at present no apparatus for making the rumpling test; this must depend on the operator, and is ordinarily thus conducted: Half a sheet of the paper to be tested is first reduced to a ball, then spread out anew, and this operation repeated several times; the papers of quite inferior resistance will quickly exhibit holes under this treatment, so that their resistance to rumpling may be expressed as *extraordinarily small*.

The folded paper is afterward taken with both hands and rubbed smartly, as a washerwoman rubs linen in rinsing it. After some practice it is not difficult to class papers in a series of seven types, from that of *extraordinarily great resistance* to that of *extraordinarily slight resistance*. The attempt has also been made to determine the loss of resistance by folding, but as this result gives the same value for very different papers, no sufficient substitute has been adopted for the rumpling test.

Such is approximately the point which has so far been reached in the testing of papers; it is probable that chemical analysis, and especially microscopic examination, has surprises in store for us, with reference to the method by which papers have been manufactured. Observations of this kind will throw light upon certain points now obscure and afford an explanation of certain phenomena whose causes now elude us.

THE CONTAL NUT WRENCH.

THE tool represented herewith is designed for the use of automobilists, who often have occasion to loosen or tighten a bolt or one of the numerous nuts that are used in the construction of a carriage. The essential part of this wrench is a steel tube forming a tool carrier. Within the end of the tube is a square hole that may be used for turning nuts of that size directly, or for receiving other pieces of steel tubing having in one end a square aperture corresponding exactly to the dimensions of a bolt or nut, and, on the other, a squared end to fit in the hole that terminates the tool carrier. With the tool is furnished a set of blanks corresponding to the various sizes of nuts and bolts that are likely to be met with. There may also be used, instead of a straight squared rod, a piece somewhat more complicated consisting of two rods united by a universal joint, so as to render it possible to loosen or tighten nuts that are located in places that are not easily accessible.



THE CONTAL AUTOMOBILE WRENCH.

1 and 2. Ring displaced for the two opposite directions of revolution. 3. Wrench with its universal joint. 4. Arrangement for reaching out-of-the way bolts and nuts.

One of the ingenious features of this tool is a ratchet arrangement that permits of revolving the tool carrier either from left to right, or from right to left. Externally to the tool carrier and on the end opposite that having the hole, is mounted a ratchet collar, the teeth of which mesh with those of a loose clutch collar. This collar is secured by a pin holding a washer which forms a bearing for a spiral spring placed between the collar and the end of the tool carrier and abutting at the other extremity against a shoulder formed upon the carrier. In order to obtain the ratchet control of the tool carrier, it became necessary to find a combination that should assure the interdependence of one or the other of the two sets of teeth. This object has been attained in the simplest manner. Around the tooth slides a coupling ring provided with a polygonal aperture, and capable of sliding longitudinally upon the corresponding periphery of the clutch collar, sleeve, and ratchet collar. This ring has a carefully calculated width, so that it may, through displacement, operatively connect the clutch collar with the ratchet collar, with the collar forming the head of the tool, or with both simultaneously. In the first two cases we have an intermittent motion; in the third position, the key forms but a single piece and plays the part of an ordinary fork-wrench. It is hardly necessary to say that the tool is provided at the extremity with a lever, which is placed in a position at right angles with the axis of the wrench when it is desired to make use of the latter, and parallel with it when the tool is to be placed in its case. This rod, which is of steel, is bent at the extremity, and kept flat near the bend. When it is slid through the two apertures through which it passes into the head of the tool, its flattened portion comes perpendicular with a slit that prolongs one of the apertures. This permits of pulling out one of the ends of the lever and making it describe a semicircle, and then a quarter-circle until it finally rests against the tool, where it is held by a flange at the end of its curved extremity.—Translated from La Nature for the SCIENTIFIC AMERICAN SUPPLEMENT.

LOG-HAULING MOTORS.*

By DAY ALLEN WILLEY.

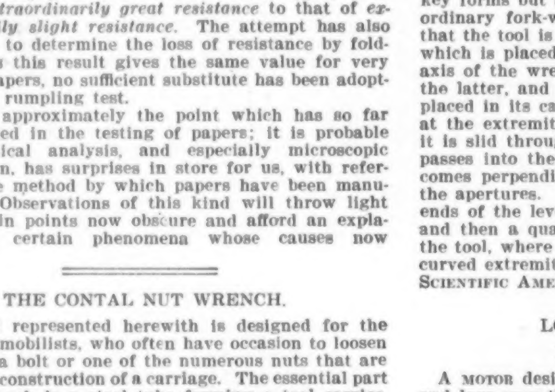
A MOTOR designed specially for transporting lumber and logs over the rough roads and even cross country in the Maine woods has been the object of much interest among the lumbermen in this section of the country, owing to its novel features. The severe winters are attended with heavy snowstorms, which frequently make the highways impassable for ordinary vehicles or teams unattached, on account of the deep drifts. The timbermen have been obliged to suspend operations in some of the districts even near the railroad lines and mills, owing to the difficulty of getting the logs over comparatively short stretches of country.

To invent a motor that would obviate this difficulty has been the study of Mr. A. O. Lombard, of Waterville, Me., for several years. Mr. Lombard and his brother are interested in pulp-making machinery, and are familiar with the conditions in the Maine woods. As the result of the experiments, Mr. Lombard built a machine at his Waterville factory, which has already been used during one winter with quite satisfactory results. It is termed by the inventor a steam log hauler, and it may be said to lay its own roadbed automatically, as it moves along the snow-covered highway or field. It consists of a steam engine and boiler mounted on a framework of heavy beams. The front portion rests on a pair of sledge runners connected with the cab by chains, which turn the runners from side to side as the front wheels of an automobile are controlled. In fact, the chains form the steering gear. The boiler and firebox, which are similar to those on a small locomotive, rest upon a lag bed, which is one of the remarkable features of the invention. It is made of sections of Jupiter steel, each 12 inches long and 8½ inches wide. The sections are joined by metal hinges, which permit the bed to pass around two sprocket wheels, each 3 feet in diameter. The sprockets are placed on axles and are 5 feet apart. On each section of the lag bed or lag is what the inventor calls a toe calk, similar to the point on a horseshoe, but extending across the lag. The calk aids in traction, as it prevents the bed from slipping when the motor is moving.

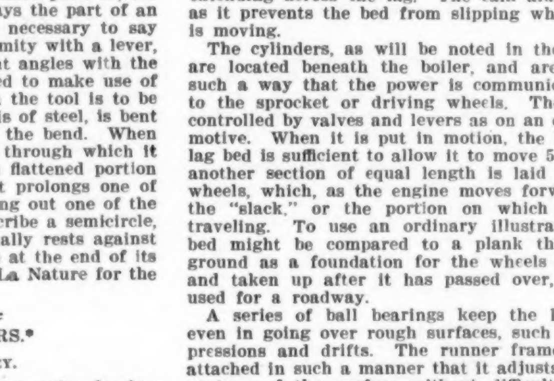
The cylinders, as will be noted in the illustration, are located beneath the boiler, and are attached in such a way that the power is communicated directly to the sprocket or driving wheels. The machine is controlled by valves and levers as on an ordinary locomotive. When it is put in motion, the length of the lag bed is sufficient to allow it to move 5½ feet, when another section of equal length is laid down by the wheels, which, as the engine moves forward, pick up the "slack," or the portion on which it has been traveling. To use an ordinary illustration, the lag bed might be compared to a plank thrown on the ground as a foundation for the wheels of a vehicle, and taken up after it has passed over, to again be used for a roadway.

A series of ball bearings keep the lag bed true, even in going over rough surfaces, such as slight depressions and drifts. The runner frame in front is attached in such a manner that it adjusts itself to the contour of the surface without difficulty. Although the "Forest Echo," as this novel locomotive is termed, weighs 14 tons, the plan for furnishing it a movable roadbed is so successful that it can be operated over the snowy surface without sinking. On an ordinary road it will attain a speed of four miles an hour, drawing four sledges with 17,000 feet of logs. It has also been used for hauling snow plows to open roads in the lumber districts, pulling the plow through drifts which had "stalled" a string of 24 horses.

In addition to the steam hauler, however, Mr. Lom-



STEAM LOG HAULER.



ELECTRIC LOG HAULER.

* If the colorant is insoluble in water, the attempt should be made to dissolve it in alcohol.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

bard has been working with an electric trolley hauler of his own design, with successful results. A power station was erected on Alder Creek, a branch of the Dead River, and here sufficient current was generated to operate two Westinghouse motors of 50 horse power in the aggregate. The necessary feed wires were installed on a mountain road about seven miles in length, where the grade is too steep to admit operating the steam hauler. The motors were placed on a platform, one in front and one in the rear, so they can be controlled singly or together as desired. A sledge runner was fastened under the front part of the platform, as on the steam hauler, and used to keep it in a direct line, being connected by an iron rod with a wheel turned by the motorman. The electric power is of course applied to the sprockets or drivers, in the same manner as it is applied to the trucks of an ordinary trolley car. On the electric apparatus the lag bed and sprockets are arranged in the manner already described. It has the advantage of being much lighter in weight, as the boiler and firebox are not required. It was tested last winter, hauling loads equal to those pulled by the "Forest Echo" up twice the percentage of grade.

The log haulers are considered so practical that the Messrs. Lombard are constructing two more to be operated by steam power, which will be employed by a lumber company on Alder Creek for getting all of its logs from the woods to its mills. This type has made trips of 25 miles, carrying loads, without being "stalled."

FIRE APPLIANCES AT THE EXHIBITION OF GERMAN CITIES IN DRESDEN.

THE great progress in the domain of fire appliances and methods of fighting conflagrations is clearly shown at the Exhibition of German Cities in Dresden. The automobile, much maligned on account of excesses committed by sportsmen, is doing excellent service in this field.

The city of Hanover exhibited the models of its automobile fire train, consisting of steam fire engine, gas fire engine, and a cart carrying a hydrant water post or fire hook contrivance for connecting a nozzle hose or supply hose to the water main in the street. Hanover is the only German city possessing an automobile fire train. This considerably reduces the running expenses, as horses are no longer required.

The fire engine house of the exhibition, by the way, is equipped with a real automobile fire train, which is served by the crew of the Dresden fire department, and exhibited by the Waggon und Maschinenfabrik, A. G., formerly Busch, of Bautzen. The train consists of an automobile steam fire engine, an automobile crew-wagon, and an automobile ambulance. The steam of the engine drives during the trip a starting machine, and, while fighting the fire, a steam pump. With an additional pressure of ten atmospheres, 502 gallons of water are supplied per minute.

Besides the automobile fire train, the Bautzen firm also exhibits at the fire engine house of the exposition a mechanical tower ladder or revoluble telescoping ladder, constructed by the firm of Fries Sohn, of Frankfort a. M. By means of compressed air or carbonic acid, which is kept in a steel receptacle, the four telescoping tubes are forced up. The different parts of the latter are attached to the upper extremities; each tube portion, when forced up, carries along its portion of the ladder. In the hands of a well-drilled fire brigade, the ladder, four stories high, is made ready for use in twenty to thirty seconds. The pressure of about ten atmospheres is sufficient to send up a fireman and hose without delay. The whole ladder, with truck, is made of iron. It may be moved with the support in a circular direction, like a revolving crane, without having to turn the truck at the same time. To all these advantages must be added still another, viz., that it can be manipulated by two men, while four men are generally required to operate a mechanical ladder.

The city of Leipsic has exhibited excellent pictures of fire stations, which must be called model in every way. A diagram shows how a fire alarm is transmitted automatically. When the alarm comes in, the station is notified by the device without the co-operation of the telegrapher. At the same time, the time-stamp clock records automatically the exact time when the alarm arrived. Furthermore, Leipsic exhibits the model of a fireman fully equipped and provided with a Giesberg smoke-protective oxygen apparatus. We present an illustration of the same, and, for comparison, one of a model with fireproof suit exhibited by the city of Kiel. Besides his fire-resisting suit, the Kiel fireman is wearing a protective mask over his head. The air to breathe is conveyed to him by means of a hose from the atmosphere. The Leipsic fireman, however, carries the air with him in a compressed state, so that he can move about freely and independent of an air hose and of the outside. The oxygen reaches his mouth from the steel receptacle on his back. The exhalations and the superfluous oxygen go into the bag on the chest, where they are sucked up by an injector and conveyed into a regenerating drum. There the alkali absorbs the exhaled carbonic acid, thus rendering the exhalations perfectly devoid of danger by purifying them. A man equipped in this manner can remain for two hours in a room filled with smoke or gas.

Of the other exhibits in fire appliances we may briefly mention the following: The fire chiefs Littmann and Herrmann, of Dresden, exhibited an artificial short circuit for strong current lines of electric street cars, by means of which the current in a trolley wire may be quickly interrupted without danger, if it hinders the firemen in their work. Furthermore, there was exhibited a plan of the telegraph and fire alarm net-work system of the city of Dresden, with a stationary and wall alarm. The Dresden firm of A. G. Handel showed a novel dismountable fire engine which can be used on wheels as well as on sleigh runners, and possesses great mobility. Berlin put on exhibition the model of her latest fire station house with normal fire train, while Bremen sent very fine models of a fireboat (for seaports) and a gas fire engine. From Breslau came the model of a highly ingenious contrivance, by means of which the ventilators in the city theaters open at once automatically, when the iron curtain is let down in case of a fire; also a sliding-cloth which can be used both for jumping and sliding. Chemnitz exhibited a rain contrivance for the protection of the wood construction of a church steeple; also a rich collection of instructive material for firemen. Finally, there was on exhibition, from Kiel, the excellent model of an up-to-date fire station, and, from Königsberg, a combined fire alarm and accident call.

The exhibits comprising the department for extinguishing fires are so varied and numerous that they afford a perfect survey of the highly developed fire departments of Germany.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Illustrirte Zeitung.

MODEL OF A FIREMAN WITH GIESBERG OXYGEN APPARATUS.

MECHANICAL TOWER OR REVOLUBLE SLIDING LADDER.

MODEL OF A FIREMAN'S SUIT OF THE KIEL FIRE DEPARTMENT.

THE GERMAN TOWNS EXHIBITION AT DRESDEN.

LITTLE notice has been taken, says a correspondent of the Manchester Guardian, of the German Towns Exhibition which has been open in Dresden during the summer. The Germans take the development of their towns seriously. As in England, though to a less extent, the population is more and more concentrating in the large towns, creating problems of administration, of health, of transit, of education, which demand the attention of the best intellects available. In Germany the service of the town is regarded as in the highest degree honorable. There is a highly-trained professional class who fill the higher posts, in most cases elected to the position, but giving their whole time to the work and receiving salaries. There are, in addition, unpaid elected councilors, as in England, among whom are to be found prominent business and professional men.

The object of the Dresden exhibition is to show the state of German towns at the beginning of the twentieth century, and to give those interested an opportunity of comparing the development of the various municipal services. The chief organizer was the Oberbürgermeister of Dresden, Herr Bentler, assisted by a committee which includes the officials of the chief German towns. Each department of the exhibition is under the control of a special committee of experts in that department. Invitations to exhibit were sent to all German towns, and exhibits have been sent by 128 of varying size and importance. Firms and companies which contract for municipal services or supplies were also offered space for exhibits, and they are well represented in a special pavilion and in separate buildings in the grounds. The main exhibition has eight sections: (1) Town engineering (street construction, bridges, harbors, waterways, etc.); (2) Town Extensions, Building Regulations and Housing; (3) Public Art; (4) Public Health, Police; (5) School Organization, including education for those beyond school age; (6) Poor Relief, Care of the Sick, Charitable Institutions; (7) Finance and Administration, including savings banks; (8) Registration and Official Books, Papers and Appliances, Statistics and Literature. There are, in addition, three separate exhibitions—the trades exhibition (already mentioned), a gas and waterworks exhibition, and an electrical undertakings exhibition.

One cannot in a brief article deal with all the sections which deserve attention. I may, however, refer particularly to the sections dealing with streets and with town extension and housing. The continental mind, perhaps from a subtle military influence, seems more awake to the need for wide, well-made streets in towns, both from considerations of transit and of public health, than the English mind. From the time when Baron Haussmann drove straight lines of communication through Paris, there has been an evident tendency to meet the modern need of rapid transit in a similar way. But the straightness of the street is not everything, by any means. It has to be wide enough for its traffic, and possibly different kinds of traffic will have to be provided for in one street. If the amenity of the town is to be preserved or increased, trees must be planted, and advantage should be taken of natural or artificial perspectives. The surface should not only be able to bear the traffic, but should be capable of rapid and effective cleansing. Finally, it is along the street lines that the drainage, water, gas and electric-supply system run, and a well-organized town will arrange these so that access can be had to them without disturbing the street. Such are some of the matters which the street engineer has to consider. There are here numerous diagrams showing streets in plan and section, often with photographs and models. In the exhibition grounds one finds side by side every possible variety of paving material, and there are also actual street sections to show the arrangement of underground works. Apparently wide streets are to be the rule in German towns. Judging from the exhibits, the whole tendency is in this direction. Separate tracks for slow traffic and for fast traffic, for foot passengers, for cyclists, and for riders are being constructed in several towns.

Better than "Haussmannizing" is to foresee the growth of a town and to make provision beforehand for the streets that will be required. Perhaps nothing in the exhibition is more interesting than the plans (many of which are large-scale relief models) of the German towns, showing the streets and roads which are not yet made. The officials of the chief towns have profited from their past difficulties, and now insist that their towns shall grow on scientific principles.

The housing question is often acute in German towns. In some cases the municipalities are themselves building dwellings for the working classes although co-operative building societies and private firms, with the assistance of public funds and under the supervision of the town councils, are the main agents in supplying the needs of the community. The build-

ing regulations are conceived in a statesmanlike way to meet different circumstances. The town areas are mapped into zones, within each of which different building by-laws apply. Thus, in Wiesbaden there are five zones and as many sets of regulations. In the zone nearest the center of the town four-story blocks are permitted, and these may be continuous, and in certain circumstances the whole of the plot may be covered by buildings. In the second zone the buildings may be grouped, but no group may have more than 20 feet frontage. The number of stories allowed is three, and not more than half of the plot may be built on. In the third zone the houses must be separate; they may have three stories, but only one-third of the plot may be built on. In the fourth zone a wider space between the houses is necessary, and only one-fourth of the plot may be built on. Houses in the fifth zone must be still further apart, and only one-fifth of the plot may be built on. The zones are not concentric; apparently allowance has been made for the natural lines of growth of the town. But it will be seen that regulations of this sort, which provide for a thinly populated "garden city" zone on the outskirts of the town, where land is cheap and where there is every inducement to the builder to cover every available inch of his ground with buildings, do much to insure the pleasantness and healthiness of the town. The principle, at least, might well receive the attention of English municipal reformers.

The widespread interest in the exhibition, which, be it noted, is practically without popular attractions, speaks well for the strength of civic feeling in Germany. The exhibition authorities do what is possible to increase the interest of the collections by arranging lectures by experts in the various departments. To-day an engineer is describing gas and water works, and a medical officer the treatment of consumptives in town. In the exhibition-rooms this forenoon there were at least a dozen classes from the high schools, under their teachers, studying the organization and working of the town services. Thus Germany prepares to face the problems of town life in the twentieth century.

FAURE TYPE ACCUMULATORS.*

THE scope of this paper is limited to the so-called "light" type of accumulators with pasted plates, which type is used almost exclusively in automobiles.

SPECIFIC GRAVITY AND DISCHARGE RATE.

As a standard of comparison we will take one of the types of accumulators used by the Compagnie Française de Voitures Electromobiles, for vehicles weighing 5,720 pounds in running order, with five passengers. This accumulator consists of forty-four cells, weighing about 33 pounds each, making a total weight of 1,452 pounds—say, in round figures, 1,500 pounds. These cells have a capacity of 180 ampere hours at a discharge rate of 40 amperes (four and one-half hours' discharge). The voltage drops during the discharge from 86 to 75 volts, but lies between 84 and 82 volts for nearly the entire period. There will be no appreciable error in assuming the average discharge pressure to be 82 volts, which would give $82 \times 180 = 14.76$ kilowatt hours. The specific weight of the battery is, therefore, $1{,}500 \div 14.76 =$ practically 100 pounds per kilowatt hour. When the capacity has fallen below 135 ampere hours, the battery is discarded. The capacity in kilowatt hours is then $135 \times 82 = 11.07$, and the specific gravity 1 kilowatt hour per 132 pounds. The average specific capacity, therefore, figures at 1 kilowatt hour per 116 pounds. Identical results are obtained by the Compagnie l'Electrique, but, as the batteries which this company employs are lighter in proportion to the weight of vehicle complete, the durability of the plates is not as great.

The specific capacity has increased during the last three years from 1 kilowatt hour per 140 pounds to 1 kilowatt hour per 116 pounds, an increase of nearly 20 per cent, which is quite appreciable. The specific capacity varies, however, largely with the rate of discharge. The results which have been given correspond to an average rate. Numerous experiments have shown that if the battery is discharged at 20 amperes, or one-half its normal rate, all other things being equal, the capacity increases about 20 per cent. This raises the specific capacity from 1 kilowatt hour per 116 pounds to 1 kilowatt per 100 pounds.

The author was told by M. Leniau that frequently batteries which are identical as far as external appearance goes are affected quite differently by a change in the rate of discharge. Some comparisons given in another part of this article lead to the conclusion that the sensibility of the plate to the rate of discharge diminishes as the meshes of the grid are smaller. This phenomenon is readily explained, as grids with very fine openings approach in form plates with solid core. However this may be, the author is firmly convinced that the greatest practical progress in storage batteries may be realized by seeking to develop batteries which are as little affected by a change in the rate of discharge as possible.

At present batteries are almost always charged at slow rates, the reason being that pasted lead plate accumulators are used almost exclusively. The usual charging rate for 22-pound cells is 20 amperes at the beginning of the charge, which is reduced to 5 amperes toward the end. M. Ducasse charges his batteries at the rate of 30 amperes, and with this rate obtains a current efficiency of 65 per cent, and a power efficiency of 52 per cent. These efficiency factors are rather unsatisfactory, the reason of the low efficiency being the fact that the batteries are too light for the weight of vehicles, being less than 30 per cent of the vehicle complete. In the case of the second vehicle referred to above, the current efficiency reaches 80 per cent and the power efficiency 60.5 per cent. In this case the battery weight constitutes a larger proportion of the weight of vehicle complete. Some discharge experiments were made with the same vehicle, with a discharge rate of 20 amperes—experiments which very nearly realize the conditions of the hypothetical vehicle, in which the frame and body weigh the same as the battery. In these experiments a current efficiency of 87 per cent was obtained, and a power efficiency of 70 per cent. These various examples show very plainly the important bearing of the rate of discharge, or, what amounts to the same thing, the ratio of weight of battery to weight of vehicle, a ratio which, unfortunately, is still nearly always too small.

Variations in the rate of charge do not seem to have as great an effect upon the efficiency as variations in the rate of discharge, but too rapid charging also appreciably diminishes the life of the battery. A very important point is that the charging current is always well proportioned to the momentary size of charge of the battery, and that, while insuring complete charge, overcharges be avoided. The sole effect of overcharges is to boil the electrolyte, to cause the separators to warp, and to deteriorate the electrodes.

Rapid charging being practically out of the question, if a vehicle is to be used nearly continuously, provision must be made for rapidly replacing the battery, which is a problem for the vehicle manufacturers to solve. Unfortunately, they seem not to have paid much attention to it. The best solution of the problem at present seems to be the so-called under-slung arrangement of the battery, in cases suspended from the body. Unfortunately, this arrangement gives a heavy and clumsy appearance to the vehicle, and seems to be disappearing. Battery spaces which are accessible only from above are objectionable. The battery cases should be accessible through a lateral opening, and be provided with rollers to facilitate removing and replacing the trays. This arrangement would be a valuable improvement, not only from the standpoint of convenience in charging but particularly because it would lead to better maintenance of the cells.

LIFE OF BATTERIES AND POSITIVE PLATES.

Referring again to the battery mentioned in the beginning of this article, which weighed 1,450 pounds, and propelled a vehicle weighing 5,720 pounds complete—the battery weight being 29 per cent of the total—experience has shown that after an average of 100 discharges the capacity of the cells falls to 135 ampere hours, a loss of 25 per cent. A set of negative plates may outlast two sets of positives, but after a renewal of the positives the battery seldom regains its original capacity. The number of charges which the battery will sustain with the second set of positive plates is less than with the first set, and the capacity drops still more for the third set. The figure of 100 discharges, given above, represents the average life of the batteries. However, with the light battery of the Compagnie l'Electrique, the average of the discharges sustained by the positive plates does not seem to exceed eighty to ninety (battery too light for the vehicle). The figure of seventy discharges given in 1900 is at present considerably exceeded, however, there having been a gain of about 42 per cent. This latter figure should be taken only for what it is worth, as the ratio of weight of battery to weight of vehicle, as well as the service which the car performs, has a great influence on the duration of the plates.

Public service vehicles are subjected to much harder use than the vehicles of private owners. In the use of the latter type of vehicles, there are a number of conditions which tend to prolong the life of the battery, such as shorter daily mileage, better care (by drivers with plenty of spare time), and above all the use of pneumatic tires and the selection of the best paved streets. The following data are taken from the repair book of a storage battery factory, which makes a specialty of renting out batteries and keeping them in repair; this concern undoubtedly makes a little sacrifice in the matter of capacity to secure greater mechanical strength:

1. A battery of forty-four cells of 180 a. h. at the rate of 40 amperes, used on a four-passenger vehicle of the Compagnie Française de Voitures Electromobiles, making a daily average journey of 28 miles at a maximum speed of 11 miles per hour; ratio of weight of battery to weight of vehicle in running order, 29 per cent. Battery was put in service on May 31, 1901; was washed out August 1, 1901; had the positive plates renewed on October 17, 1901, after 137 trips; was washed on December 23, 1901; had the positive plates changed again on February 4, 1902, after 237 trips; was washed again on April 15, 1902; had the positives renewed a third time on June 4, 1902, after 342 trips; was washed on September 3, 1902, and was finally discarded on November 6, 1902, after 482 trips. The negatives outlasted four sets of positives. It will be understood that the battery was recharged after every trip.

2. A battery of the same kind as the preceding, used for the same purpose, but on a lighter vehicle belonging to the same company; ratio of weight of battery to weight of vehicle in running order, 33 per cent. The battery was put in service June 25, 1901; was washed on October 30, 1901; positives were changed on January 11, 1902, after 196 trips; cells were washed on April 24, 1902; positives were changed a second time on July 5, 1902, after 370 trips; battery was out of use from July 5 to August 29, 1902, and was put back in service on August 30; was washed on December 15, 1902, and was discarded on March 2, 1903, after 185 more trips, making a total of 555 trips. The negatives outlasted three sets of positives and sustained 555 discharges.

3. Battery of forty-four cells of 120 ampere hours capacity at a discharge rate of 32 amperes, used on a vehicle with motor fore carriage, weighing complete 3,960 pounds; the weight of the battery was 1,100 pounds, or 28 per cent of the total. This vehicle was used by a private individual and was subjected to less severe treatment than the vehicles plying for hire. The mileage on one charge never exceeded 25 miles, at a speed of 11 miles per hour. The battery was placed in service June 5, 1901; was washed on October 25, 1901, and again on February 2, 1902; the positives were renewed on May 13, 1902, after eleven months' use. The car was out of use from July 16 to October 8, 1902. The battery was washed on October 7, 1902, prior to being placed in service again; the battery was washed again on February 3, 1903, and was finally discarded on April 2, 1903, after the second set of positive plates had been in use for nine months. The negative plates lasted for twenty months of actual service.

There are three conclusions to be drawn from comparing these examples: (1) The second battery sustained the greatest number of discharges and the ratio of its weight to that of the vehicle was 33 per cent, instead of 28 per cent, as for the others; (2) when the positives show a very long life, the negatives outlast fewer sets of positives. The maximum number of discharges which the negatives will sustain is between 500 and 550; at that period a sort of disintegration takes place and the active material becomes detached from the support, which increases the internal resistance and diminishes the capacity of the battery. (3) The first set of positives lasts longer than the following sets.

LIFE AND COST OF MAINTENANCE.

Great efforts are being made to increase the durability of the plates. Some manufacturers try to prevent the active material from shedding by inclosing the plate in a porous envelope; others seek to prevent one of the greatest causes of trouble, short circuits between plates, by making provisions allowing the active material which will necessarily become detached in time to drop freely to the bottom; still other manufacturers seek to reduce the cost of construction by manufacturing the plates entirely by mechanical means.

In a storage battery factory in which the manufacture is effected entirely by machinery—that is to say, where the oxides, instead of being applied to the grids by hand in the form of paste, are applied in the state of a dry powder by means of a hydraulic press—a skilled workman can easily prepare 700 plates in eleven hours, while if the work was done by hand hardly eighty could be completed in the same time. This should certainly lead to a considerable reduction of the cost of manufacture.

The maintenance of storage batteries comprises at present practically only two factors, the renewal of plates and the renewal, at long intervals, of the jars and accessories. Breakage of jars, of covers and connections is now exceedingly rare. As to the ebonite separators between the plates, they seem to be entirely unaffected by wear, or, rather, they have not been in use long enough to determine their length of life; at any rate, they need not be renewed in less than six or seven years. The cost of the plates forms only about one-half of the cost of manufacture of the battery complete, and that of the positive plates consequently only one-quarter.

The cost of maintenance of the batteries is given by the Compagnie l'Electrique as not exceeding 4.5 francs (90 cents) per day. This applies to batteries made by the company itself. M. Verdon, director of l'Equipage Electrique, gives the same figure for the cost. This maintenance figure seems to us a little too low, but experiments made by us, covering 26,000 vehicle days, show the daily expense not to exceed 5 to 5.2 francs, even under the most unfavorable conditions. It is, of course, understood that these repair figures imply thorough care of the accumulator, because in connection with batteries everything depends upon good care, and the life of the battery may be doubled by always keeping it in perfect repair.

What must be done to keep a battery in good repair? The density of the electrolyte must be tested from time to time, and the batteries washed out to remove active material which has become detached from the plates. Too frequent washing is, however, not to be recommended, as the handling of the plates tends to hasten the shedding of the active material; it seems to be good practice to wash the batteries after every forty or fifty discharges. The connections must always be maintained in good condition, the cells well wedged in their trays, and above all the batteries must never be allowed to remain discharged for any length of time.

CONCLUSIONS.

By comparing the results of practical experience in recent times with those which were obtainable in 1900, improvement is observable all around. I do not believe that the manufacture of plates has reached the limit of perfection, at least not from the point of view of capacity and mechanical strength. Of course the manufacturers have made efforts to develop these two factors by improved manufacturing processes, insuring greater porosity of the plates; by a more perfect application of the active material to the grids, or by making the positive plates, or even both of the electrodes, in the form of porous envelopes surrounding the active material. This latter solution of the problem, which seems perfect in principle and which the manufacturers claim to have found very satisfactory, does not seem to have been found very satisfactory by users. Electrodes thus constructed also lose a considerable fraction of their original capacity after a certain number of discharges, owing to rather complex causes not yet completely understood.

We would point out again that entirely mechanical processes of manufacture are just as advantageous in this as in other lines of industry, as they insure uniformity in quality of the product and reduce the cost of manufacture. In addition, the "pasting" of the plates by means of the hydraulic press admits of closely regulating certain important qualities—a greater pressure insuring greater durability of the plates, and a smaller pressure increasing the specific capacity and the rapidity of formation.

In conclusion, the electrodes themselves have remained about the same as they were in 1900—that is to say, they deteriorate still too rapidly. The greatest improvement, in our opinion, which has been made, has been in the assembling of the cells and in the accessories.

The separators, for which perforated and corrugated sheets of ebonite are coming into use more and more, avoid short circuits between plates and permit any active material becoming detached from the plates to drop to the bottom of the cell. The in-

* Abstract from a paper by M. Levazzari, read before the Second International Automobile Congress. This résumé of storage battery conditions in France is interesting as showing what a lack of durability the Faure, or pasted batteries, there in use for propelling electric carriages, have as compared with the Planté type of cells, or, indeed, cells of the pasted type even, as manufactured in America.

side bottom wall of the cells is provided with ridges, as high as possible, which keep the lower edge of the plates at a certain height above the bottom of the cell and permit a certain amount of active material to accumulate in the bottom of the cell before the plates become short circuited.

The cell covers have also been the object of improvement. Ordinary plates of ebonite, often in several pieces (on account of the soldered connections used), have been replaced by solid covers, often of double thickness, molded, ribbed and provided with a perforated stopper to admit of the escape of gases. In this manner the spilling of the electrolyte, which formerly was the cause of rapid deterioration of the trays and facilitated short circuits between cells, is now almost entirely avoided.

The connections between cells also were a great source of difficulty formerly, but this problem has now been solved. Formerly the connection was generally made by wires soldered to lugs of lead plates, and these wires often broke, and the arrangement made it difficult to inspect cells with a single piece cover, as it was necessary to break the connections when the cells were to be opened. At present strips of lead foil secured to the lugs of the plates by bronze bolts are generally used. By keeping these connections fairly well lubricated, all trouble of breakage is avoided.

An idea of the improvements made in automobile storage batteries during the last three years may be gained from the following comparisons, based upon the author's personal experience: In 1899 and 1900, in a service which comprised the maintenance of ten batteries, there was at least one mishap per day due to cracked jars or broken connections. In a service absolutely similar, but which comprises an average of thirty batteries in daily operation, since the end of 1900 there has not been one case of a broken cell in 1,000 trips, and in thirty months there have been only two cases of broken connections.—Horseless Age.

TEA GROWING IN INDIA.

WELL-CARED-FOR tracts of level or mountainous land are used in India for the cultivation of tea. The term "gardens" is used to denote these tracts, which vary in size from 100 acres in the hill districts of the lower Himalaya Mountains to 1,500 acres on the plains. The tea bush is raised from seed, which is very carefully planted about one inch deep in a nursery of soft, fertile soil. In the early days of tea planting the seed was sometimes scattered broadcast from the back of an elephant. The young plants require a rich soil and a very moist heat in order to thrive well. When the plants have obtained a height of twelve inches they are transplanted. It is generally considered that a bush requires about sixteen square feet of well-cultivated soil around it to gain the best results. The tea is planted in regular rows, either in squares or triangles. The triangular planting, which gives each bush exactly the same space from its neighbors, effects a saving of nearly 15 per cent space, as it is possible to plant 115 bushes in the same area that would be occupied by 100 plants in rectangular planting.

By the third year the plants should be from four to five feet high, and they are then pruned down to about twenty inches, so as to promote the growth of the new branches and tender shoots and thus produce a larger number of new leaves. The methods of pruning vary greatly and in some cases the plants are pruned before they are taken from the nursery. The bush is so pruned and trained that instead of growing tall it is kept short and broad in order to furnish a greater plucking surface. When the young bushes have developed succulent shoots upon which there are four or five leaves they are said to have produced their "first bush"—that is, they have sprouted sufficiently to pluck. During the rains successive "flushes" occur at intervals of fifteen to twenty days, varying according to the soil, cultivation, and climate. The top part of the shoot is the only portion that is plucked. It includes the bud and the first two or three leaves, acording as fine, medium, or coarse tea is wanted, for tea can only be made from the young and tender leaves, and the younger and tenderer the leaf the better the quality of the tea.

Plucking is performed by turning the thumb downward and nipping off the shoot between the thumb nail and the forefinger. It is done almost entirely by women and children, as it is comparatively easy work and does not require any physical strength. Each plucker carries a large open-mouthed bamboo basket about two feet in diameter and three feet in length, tapering toward a rounded bottom. The leaf is thrown into this basket and protected by a covering from the rays of the sun, which would otherwise cause it to turn red. Late in the afternoon the leaf is brought to the factory, where it is carefully weighed and examined by the manager and his assistants and the several amounts entered in a book against each plucker's name. To earn a full day's pay a certain number of pounds of leaf must be brought in. This amount is determined beforehand by the manager and varies, as it depends upon the condition of the "flush." Extra pay is given for whatever quantity brought in above the required amount of the day, and in this way many good workers earn double pay during the height of the season. The rate of pay for the extra work is always relatively higher than the regular wages in order to offer an inducement for hard work.

The leaf is taken to the withering room after it has been weighed, and evenly spread upon wide trays. The men who spread the leaves work with remarkable dexterity, making a pound of the green leaf cover about one square yard. By morning the leaf is sufficiently withered to be rolled without being broken, and is then taken to the rolling machine. The object of rolling is to liberate the juices of the leaf cell, and during the operation the leaf changes color from a bright green to a slightly yellowish tint. In former years the rolling was done by hand, and eighty pounds was a good day's work for one man; now the machine does about three times that amount in one hour. The rolled leaf is then taken to a cool, dark, moist room, where it is spread out on a cement floor, or in long trays, and covered with a wet cloth, where it is left to ferment or oxidize, which turns the leaf a dull, rusty color. This fermentation is a most important part of the preparation of the tea leaf, and upon the process depend the flavor and appearance. There is no rule for the length of time of the operation, one garden's product requiring six hours, while another may take only two. After fermentation has proceeded far enough, the leaf is rolled again for a few minutes, when it is taken to the firing machine, and subjected to a blast of hot air, between 240 deg. and 300 deg. Fahrenheit, for twenty minutes. This instantly stops fermentation and removes the moisture from the leaf, and causes it to curl up and blacken. It comes out of the machine three-fourths fired, and is then again fired at a much lower temperature. It is now dry and crisp, and is the tea of commerce. During the process of curing it is estimated that about three-quarters of the weight of the green leaf is lost.

The tea is then taken to the sorting room, where it is first spread on a cement floor, and women carefully pick out any foreign matter, such as little sticks and pieces of stone, which somehow find their way into the mass of tea. It is then put into a long sieve in which are wire meshes of different sizes. The tea which drops through the different meshes is called "unbroken tea," which is the finest grade, as it is made up of the tip of the bud and the delicate part of the leaf. The tea which does not find its way through the meshes traverses the entire length of the sieve and falls into large baskets, from which it is taken and placed in a machine to be broken up fine and again sifted and automatically sorted into various grades. The names given to the different qualities are as follows: The unbroken teas are divided into Flowery Orange Pekoe, Orange Pekoe, Pekoe, and Pekoe Souchong. The broken teas include Broken Orange Pekoe, Broken Pekoe Souchong, Broken Pekoe, Fannings, and Dust. The division into these classes is not uniform among the different tea gardens, and as the names given to the various grades are more or less optional, some confusion arises when attempts at comparison are made. Just before it is packed into lead-lined chests containing 100 pounds it is refired a short time to remove any traces of moisture gathered while being worked.

Consul-General R. V. Patterson, at Calcutta, says that the area under tea at the end of 1902 was 525 252 acres, nearly two-thirds being in the valleys of the Brahmaputra and Surma, which contain as much as 339,640 acres. In Bengal the area under tea was 135,158 acres, or about 25 per cent of the whole. Its cultivation is therefore to the extent of nine-tenths in the two provinces of Assam and Bengal, the other tenth being divided between northern and southern India. The area added to tea growing during the last five years was about 55,000 acres. Under the discouragement of low prices of tea, caused by placing on the market more than their consuming capacity, endeavors have been made to restrict the cultivation and production and to supply a better quality in smaller quantity, so that the addition to the tea area in the last two years was only about 2 000 acres, considerable areas on which tea could not be grown with profit, at the present range of prices, having been abandoned. From Assam reports were received from 805 estates for the year 1902, with an area of 339,640 acres, the average area of an estate being about 420 acres. In Bengal 300 acres was the average for 452 estates and in Travancore the average for seventy-five estates was 337 acres. In other localities the average of the estates is much smaller. These figures only refer to tea-bearing acres. While the area has increased since 1885 by 85 per cent, the increase in production has been 167.7 per cent.

The actual production in 1902 is reported to have been about 190,000,000 pounds, which is 56 per cent larger than the reported production of ten years previously, in 1892. The average of the last five years—the yield of tea to the acre—dividing the total yield by the area of land bearing mature plants has been as follows: Assam—Brahmaputra Valley, 383 pounds; Surma Valley, 478 pounds. Bengal—Duars, 488 pounds; Darjeeling, 278 pounds. The number of persons employed in the industry in 1902 was 606,830 permanently, and 90,940 temporarily. Of the production the United Kingdom takes about 97 per cent. In 1902 the United States took 2,672,000 pounds, shipped direct, nearly double the amount of the previous year. It is claimed that one pound of China tea will produce five gallons of liquid tea of a certain flavor and color, while 7½ gallons may be made from one pound of India tea.—Evening Post.

A PREHISTORIC SETTLEMENT.

A REPORT was presented at the meeting of the Cambrian Archæological Association describing the investigation by the Rev. S. Baring-Gould and Mr. Burnard at Tre'r Ceiri. On June 29 they visited the place along with the Rev. J. Fisher and Mr. Harold Hughes, and there sketched out a plan of procedure. According to their commission, they confined their attention to the cytiau and left the fortifications to be investigated on a later occasion. The number of cytiau within the inner walls—an area of about five acres—could hardly be determined with certainty, but probably the huts numbered considerably over a hundred. The highest point of the site within this area was east, where the ground rose to 1,591 feet above sea-level and fell somewhat abruptly to a lower terrace, and then sloped gradually to the western limit of the inner wall. The highest point had a cairn-like appearance, but they believed it to be mainly natural. The extreme summit was evidently artificial. The cytiau were situated in groups on the terrace and on the slope, and also under the inner face of the walls. In the latter case each hut had a wall built against the rampart with, in some instances, a narrow intervening space. The forms and sizes of the huts were varied; some were circular or pear-shaped, and others again were oblong and rectangular. In a few instances the doors of the cytiau opened out of a small space or hall entered through a common doorway. The entrances faced various points of the compass. Occasionally the huts were double, one chamber leading into another. In a few instances an outer curved wall protected the entrance. The entrances varied in width from a little over 2 feet to 4 feet. The walls of the huts, which were very rudely built, were usually 4 feet wide, and varied in height from 3 feet to 6 feet. The subsoil of the site was a mild clay, and resting on this was a crust of peaty earth of varying depth, carrying on its surface a luxuriant growth of heather and whinberry plants. This peaty earth carried a certain amount of water which it retained, and in this it was assisted by the clay subsoil. This rendered the hut sites damp, for wherever a hole was sunk into the subsoil water accumulated in small quantities. To minimize this disadvantage the builders of the huts excavated the greater portion of the interior down to and into the subsoil, and then filled the pit with rubble and roughly paved the floor with flat stones. Sometimes the excavated portion of the hut was filled with flat stones placed vertically, and in one case regularly built drain-like cavities acted as catch-pits under the paved floor. There was no drain to carry the accumulated water out of this hut. So long as the floor was raised sufficiently above the drainage water-level, the occupants must have been satisfied. The roofs of the huts were probably of thatch, made with rushes or heather; they were certainly not of stone, for the accumulation of this material in the interiors represented wall ruin only, while the shape of the greater portion of the huts would have made a stone roof impossible. Where practicable all the huts examined were explored right down to the subsoil so as to make sure that domestic objects had not found their way between the rude paving stones down to and beyond the stone packing. It was not practicable to do this in all cases, owing to the ruined condition of the walls. Having referred to the injury done to some of the cytiau as the result of an old woman's dream that a copper caldron full of gold was buried in Tre'r Ceiri, Mr. Baring-Gould gave a detailed account of the thirty-two cytiau examined and of the finds made therein. In No. 1 coal only was found; in No. 3 a dozen pieces of dark pottery, some pebbles and a small fragment of pointed iron were found; in No. 4, some charcoal, two spindle whorls (one broken), and pebbles, both large and small; in No. 5 a spindle whorl, pieces of ox tooth, and some charcoal; in No. 6, a combined adze and hammer of much corroded iron, a part of an iron blade, some small fragments of bone, and ox teeth; in No. 7 a spindle whorl, two iron objects—one about 3 inches long, the other a crescent-shaped piece, both much corroded—and some small fragments of bone; in No. 8 a bronze triskele and a large ribbed melon-shaped broken bead of blue-glazed porcellanous paste; in No. 10 a bronze fibula plated with gold, highly ornamented, a much-corroded iron ring, with a diameter of 2 inches, and another ribbed melon-shaped bead of blue-glazed porcelaneous paste; and in the others pieces of charcoal, fragments of red and black pottery, lumps of corroded iron, a bone comb, a few sling stones, pebbles, and bits of bone. Continuing, the report stated that the exploration lasted ten working days. Of the thirty-two huts examined twenty-three yielded charcoal or objects indicative of human occupancy and the remaining nine were blank. The pottery found was wheel-made and late Celtic in character, excepting the tiny fragments of thin red pottery found in two of the huts. These were undoubtedly Roman. Continuing, Mr. Baring-Gould said they had come to the following conclusions: "(1) That the fortifications were erected and occupied by that people to whom the finds appertained. There was no evidence of any further occupation, not a trace of flint tools or weapons, not a fragment of pottery of the Bronze Age, nor were there any indications, with a possible exception of the bone-comb, of a later occupation. (2) That Tre'r Ceiri was only temporarily, and that for a short time, occupied in the summer season alone as the amount of charcoal found was remarkably small, and some of the cytiau seem not to have been occupied at all. The exposed position of Tre'r Ceiri and the excessive dampness of the site would render it impossible of occupation during winter. (3) That the race which erected the walls and constructed the huts was Celtic, probably British, and that the period to which they belonged was the first or second century of the Christian era. Our reasons for coming to this conclusion are as follows: (a) The pottery is wheel-turned and distinctly Celtic, but along with this was found a small amount of what is certainly Roman pottery; (b) the amount of iron found proves that the tenants belonged to the Iron Age, but there was nothing in the character of the tools and weapons found to determine the precise period in that age; (c) however, the fibula is unmistakably Celtic, and resembles one found at Æsica on the Roman wall; (d) the two porcelain beads are of Egyptian manufacture—one of them is the finest that had been found and recorded in the United Kingdom, and by its shape paste and glaze reveals its origin as either Alexandria or the basin of the Nile (these must have been imported probably during, or even slightly preceding, the Roman occupation); (e) the distinguishing Celtic ornament of the fibula practically ceased or became degraded after the second century in Britain. During the first 200 years of the Roman occupation the originality and elegance of Celtic ornament influenced decoration in Britain and even in Rome, being so totally different from the stiff and conventional character of Roman ornamentation. (4) The extraordinary rudeness and clumsiness of construction of the walls and huts seemed to show that the builders had not been influenced by the Roman art of wall building, and this, in their own opinion, pointed to the erection of the fortress at an early period of the first century." Concluding, Mr. Baring-Gould and Mr. Burnard offered some suggestions for continuing the investigations and making a thorough exploration of the fortress. They also recommended Mr. Wood, the owner of Tre'r Ceiri to decide on some public museum, under the charge of a competent curator, where the relics found or to be found might be carefully preserved for the sake of their great importance as a contribution to the knowledge of the arts of the British at the dawn of the history of our island.

TANGENTIAL WATERWHEEL EFFICIENCIES.*

BEING AN EXPERIMENTAL INVESTIGATION OF THE RELATIVE VALUES OF DIFFERENT BUCKET SHAPES.

By GEORGE J. HENRY, JR., Member A. S. M. E., Associate Member A. I. E. E.

IT is not the writer's intention to attempt to determine the equation for the so-called true hydraulic curve, or to exhibit new and improved bucket shapes which will greatly increase the efficiency of a waterwheel, but rather to discuss some of the well-known shapes of buckets, and particularly the ellipsoidal as compared with the general form of the Pelton bucket.

The conclusions arrived at are not theories deduced entirely on paper, but are the result of a very elaborate series of experiments carried out since 1899 in the special laboratory of the Pelton Water Wheel Company with a view of scientifically and practically determining, beyond a doubt, the relative advantage of different bucket shapes. The printed information on this subject heretofore has been extremely misleading, to say the least, and usually the result of incomplete theorizing within very narrow limits. The conclusions arrived at have usually been entirely different from those that would have been obtained had the theorist taken into account, instead of neglected, certain factors of extreme importance to the deductions.

We will not again parade that elusive ghost—"a new bucket shape"—that is conjured up by every suburbanite with a "mechanical turn of mind" who has wielded a garden hose. It is our intention, however, to present a few facts for your worthy consideration, and particularly to those of you interested in obtaining the best results from waterwheel plants.

During the writer's experience in the design, construction, and operation of tangential waterwheels for the past twelve years, new types of tangential waterwheel buckets have been brought out with a startling rapidity; every rain seems to bring out a new crop like mushrooms. Most of them do not last any longer than mushrooms. Some few, due to liberal advertising, are forced before the public, but usually die a natural death after a short time, as much because of poor engineering or financial disability, as weakness in bucket design. The average inventor fails to consider the work of those who have gone before, and suffers from the belief that if the Patent Office will grant a patent, there must be superior results obtainable. Or, rather than giving actual results, such as Prony brake measurements on carefully designed wheels for comparison, he will state that it will "reverse a Pelton" when put on the same shaft, etc., all of which means nothing as far as relative efficiency goes.

Another frequent fallacy is that to get maximum efficiency it is only necessary to provide a bucket which will receive one blow at each revolution, usually at the instant of entering the stream.

To obtain the best efficiencies it is necessary to have the proper pipe line, gate valves, nozzles, waterwheels, and buckets, wheelcase, wheelpit, and tailrace, and all of these parts must be properly designed for the particular conditions under which they are to operate, and all will vary with the head or pressure, the water quantity, and the revolutions which the wheel is to make. Many a waterwheel bucket has been overworked for years, and then charged up with losses that occur because of its being improperly worn, due to this overwork. Again, buckets are frequently charged up with all kinds of losses which are really due to something for which the bucket is not responsible. Pressure, or wheel diameter, or speed on a given wheel, cannot be varied radically without materially altering the efficiency. Many hydraulic plants are in operation and developing not over 65 per cent between the flume and waterwheel shaft where the *bucket* itself is capable of developing 90 per cent, and where a very inexpensive change could be made which would increase the gross efficiency very materially and cause a great saving in the water bills. On the other hand, there are probably more errors made in buckets than in any other one element of a tangential waterwheel plant. The writer knows of but one inventor, Mr. L. A. Pelton, who has based all of his work on tangential wheels on actual practical results obtained through laborious experimental work. All other shapes, as far as we know, are the result of a happy, or, usually, an unhappy thought, and it is curious to note how at variance are the shapes and arguments put forth to support each type as it is introduced.

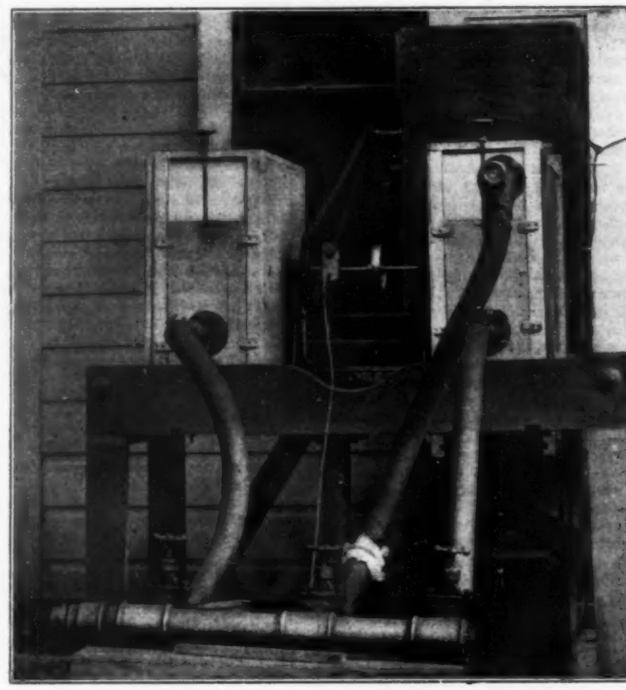


FIG. 2.—A FRONT VIEW OF THE EXPERIMENTAL APPARATUS.

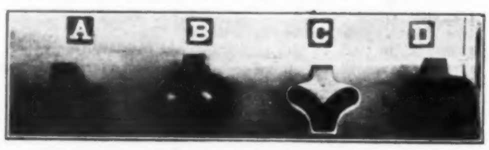


FIG. 3.—SOME OF THE TYPES OF BUCKETS USED IN THE EXPERIMENTS.

A. One of the early forms of Pelton. *B.* Latest type of Ellipsoidal. *C.* Hug. *D.* One of the recent forms of Pelton.

The Cazin bucket is built up on the entering lip and cut away on the sides, which are made rectangular, and Mr. Cazin issued quite a mathematical treatise, in the form of a trade catalogue, to prove the value of his type of bucket.

The ellipsoidal type of bucket is cut out in front like the Dodd, and is supposed to contain smooth interior cavity surfaces, whereas the De Reamer has a number of interior ridges or walls to guide the water in fixed lines along the surface of the bucket cavities. In the ellipsoidal, before mentioned, great stress is laid on the smooth interior surfaces, from which 1 or 2 per cent is supposedly gained, and then the front is largely cut away, resulting in a loss usually much more than is gained by the smooth surface.

Some inventors insist that buckets should discharge from the top or edge nearest the wheel center, such as the Risdon and Hug. Others, again, that the discharge should be from the front and side furthest from the center, and still others, that this discharge should be from the sides, as in the Cazin, Berry Blue, and Pelton. This latter class is by far the more numerous.

In actual practice, each bucket, of course, discharges to some extent on all three sides of the cavity, but the maximum discharge may be distorted to any particular point by changing the interior surface of the bucket cavity. Some inventors insist on few and others on many buckets located around the wheel periphery. In fact, the whole question of bucket design seems to be largely a matter of guesswork, usually based on assumptions entirely at variance with facts, and therefore leading to wrong conclusions.

An inspection of the stream diagrams, made from actual experiments, will make this question of stream path over the surface of the different bucket shapes better understood. It should be borne in mind that the bucket is doing work throughout its entire path, within the stream lines, and we therefore give the lines taken by the water in three different positions of the bucket. First, at the moment of entering; second, at the point of developing maximum power; and third, in its final position before leaving the stream. In these diagrams the same relative bucket and wheel and stream dimensions are maintained for each form, so that comparisons may be more readily made.

With these diagrams before us, let us bear in mind that to obtain the best possible bucket efficiency it is necessary that the water jet be taken up on the bucket surface and brought to as near rest as possible with the least loss of energy. This loss will then be made up of:

1. The discharge velocity with which the water leaves the bucket with respect to a point fixed in space. Note that this velocity will vary with every position of the discharge as bucket moves.
2. Air and surface friction inside the bucket.
3. Imprisoned water in the bucket.
4. Variation in the stream form, producing erratic conditions of impact and flow on the bucket surface.
5. That occasioned by the stream being displaced by the entering bucket.
6. Eddy currents in the buckets.
7. Water which does not give up all its energy to the bucket (a special case of the first condition mentioned above).

The following methods of correcting these losses suggest themselves:

1. If the water moves in a curved path on the surface, being taken up on a surface as nearly tangent to the entering jet as possible, and is turned through a curve of as nearly 180 degrees as possible, still allowing the discharge to clear the back of the next bucket, and the discharge is at the same distance from the wheel center at all times, the first loss will be kept down to a minimum.
2. If the water moves in a smooth curved path at all times, as shown in the Pelton bucket diagram, Fig. 4, and the stream form is retained, spreading out gradually and encountering no sharp corners or angles, and the discharge is thin and fan-like on the sides, and the least number of buckets used, then the air and surface friction will be a minimum.
3. The imprisoned water will cause very little loss if the bucket surfaces are smooth and so shaped on the back and front that the water, after expending its energy, will freely leave the wheel.
4. Variations in stream form producing erratic con-

* A paper read before the Pacific Coast Electric Transmission Association at San Rafael, Cal., June 16, 1903. Copyrighted, 1903, by George J. Henry, Jr.

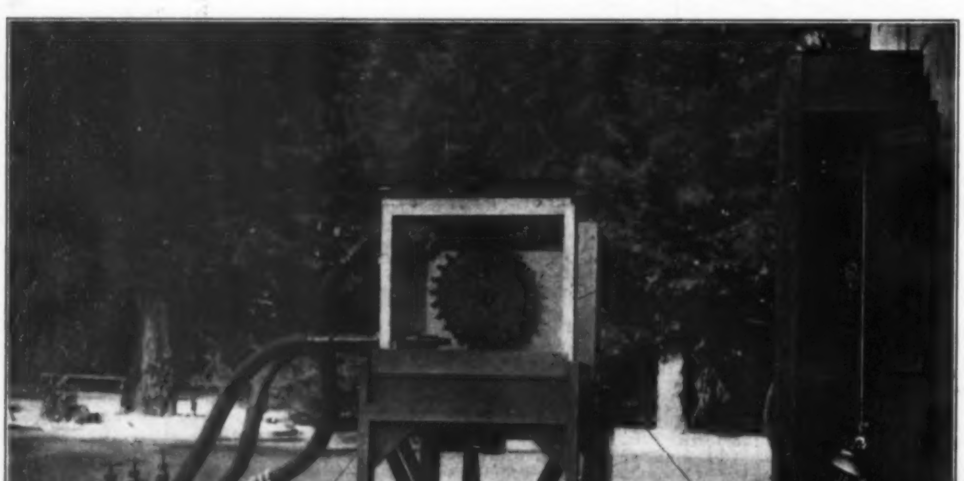


FIG. 1.—ONE OF THE PIECES OF EXPERIMENTAL APPARATUS USED IN THE INVESTIGATIONS, SHOWING THE ARC LIGHT AND SHUTTER FOR ILLUMINATION, THE WHEEL AND NOZZLE INCLOSED IN A PLATE-GLASS CASE, AND EQUIPPED WITH PRONY BRAKE AND ACCESSORY MEASURING APPARATUS.

ditions of impact and flow will be avoided by carefully following the angle of the front and the curvature of the cavity surfaces.

5. The shape of the cutting edge and the dividing knife, and their relative angles to the stream, are the principal causes of the loss occasioned by the displaced stream.

There are still other losses which should form an important consideration in wheel design, but which are not directly affected by the bucket shapes. These are:

8. Journal friction.

9. Windage due to the wheel acting as a centrifugal blower.

10. The losses in the nozzles, gate valves and pipe lines.

Every waterwheel plant has all of these losses to a

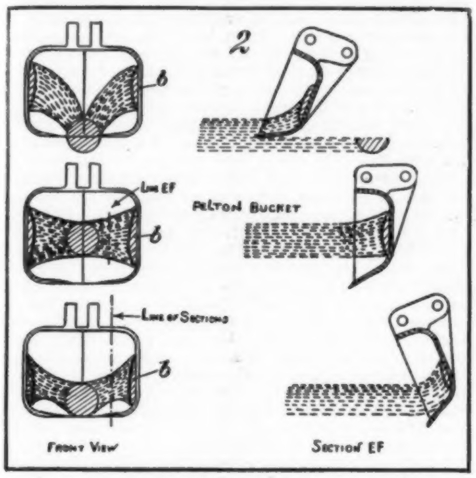


FIG. 4.—DIAGRAM OF DISCHARGE FROM PELTON BUCKET. NOTE THE THIN FAN-LIKE DISCHARGE AT B.

greater or less extent, and it is obvious that when 80 per cent is then obtained from an operating wheel, the improvement of any one of these, or, for that matter, the entire elimination of any single loss, if this were possible, would not, to any great extent, improve any wheel's gross efficiency. The writer has a number of times obtained as high as 90 per cent efficiency in laboratory test on buckets only.

Let us give some attention to the above detailed losses, and endeavor, as far as possible, to determine those points, the careful calculation of which will obtain for us the best possible tangential waterwheel bucket.

1. Given a certain stream of water at a given spouting velocity, it is advisable that this be taken upon the bucket surfaces of just enough buckets to catch every particle of water on the dividing wedges and turn it all on the curved surfaces, and discharge it at just enough velocity (and entirely in a direction at right angles to the entering stream axis) to clear the next following bucket. This resulting velocity will be the tangent of the discharge angle, multiplied by bucket velocity.

2. The air and surface friction must be maintained as small as possible by the use of a nozzle which will give a perfectly circular and solid stream. The bucket surface and cutting edges must be of a shape which, with a minimum wetted surface, will allow the stream, without crowding at any point, to spread out in a thin fan-like discharge on each side. The surface must be such that the water will not adhere, and as smooth as possible.

The surface may be ground and polished, or better, ground and well painted with a special compound. If all of these points are carefully studied out and the front of the bucket properly shaped and not cut away too low, the imprisoned water will not cause any appreciable loss.

The windage will also be a minimum if the number and surface of the buckets is a minimum.

The above losses and considerations for their prevention are all of such a nature, and so entirely interdependent, that their quantitative value cannot be predetermined except in a general way. In designing a waterwheel, however, it is certain that the exercise of the most careful judgment is necessary in the laying out of the surfaces, so that all the losses, or at least their sum, or total bucket loss, will be kept down. Thus, if too much bucket surface be allowed, we increase both surface friction and windage for a given output, and if we attempt to cut these down by reducing the surface, we crowd the stream, so that eddy currents will occur and the stream will not properly discharge from the bucket side, as shown in Fig. 5.

It will now be seen that it is absolutely impossible to get equally as good results from a certain shape of bucket, under all conditions of wheel and stream diameter and water pressure, but that to get the best efficiency, a bucket must be designed for each set of conditions.

When an investigator says, "Suppose no frictional resistances exist in the bucket, and let the stream be prevented from spreading laterally; also neglect losses due to impacts, loss of head in the nozzle, journal friction and resistance of the air"—however interesting a conclusion he may come to mathematically, the result to the purchaser or builder is not only entirely useless, but frequently misleading to a dangerous degree.

By carelessly omitting some of the above considerations, many makers who have obtained very good results on some one wheel, fail to secure even a reasonable efficiency from others, built on similar lines, but for working under different conditions.

The writer believes that there is no such thing as a bucket shape, which, by simply enlarging or reducing, may be adapted to any set of conditions.

Some of the familiar bucket types are grossly deficient in the most elementary requirements for efficiency and best practical results.

All bucket shapes may be divided into two classes, in the first of which we have a variation in the shape of the cups on each side of the dividing wedge, and the second in which we vary the front wall or entering lip. Let us give some attention to these two points.

In the first place, no stream of water can divide on the central wedge and gradually spread out, if the surface of the bucket is concave with a deepest point (see Fig. 6), as there will be a tendency for all the lines of flow to cross on this point *a*, and then spread out again after passing over it. This crossing or

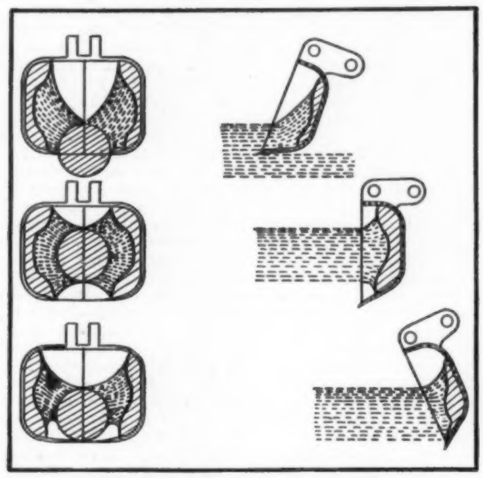


FIG. 5.—DIAGRAM SHOWING THE EFFECT OF OVERCROWDING A WATERWHEEL BUCKET RESULTING IN UNEVEN MECHANICAL EROSION, CUTTING OUT THE CORNERS RAPIDLY.

"impact accumulation" and the consequent eddy currents at the deepest point cause more rapid wear here than elsewhere, as also a considerable reduction in efficiency. The water again spreads out, after crossing the deepest point, but before leaving the side of the bucket the curvature of the walls tends to produce a second node, as shown at *b*. It is the writer's belief that there should be no single deepest point in a waterwheel bucket, but rather that the flowing stream, after impact on the dividing wedge, should follow, practically, a cylindrical surface, so that the stream may spread out in a fan-like shape at discharge, as shown in Fig. 4.

In reference to the front of the bucket, this should be neither too high nor too low. If the front be too high, as in the Cazin, then it must be set at such an angle of entry to avoid disturbing the stream, that there will be eddy currents set up; if too low, all the water will not be caught without a great increase in bucket surface. Under no circumstances should the entire front be left out, as in the Berry and Doble as used at Blue Lakes.

(To be continued.)

THE IMPROVEMENT IN STEEL TREATMENT.

EVERY process or discovery which tends to make steel stronger and more durable is of supreme interest to the automobilist as to all other engineers. We therefore make no apology for referring to the paper

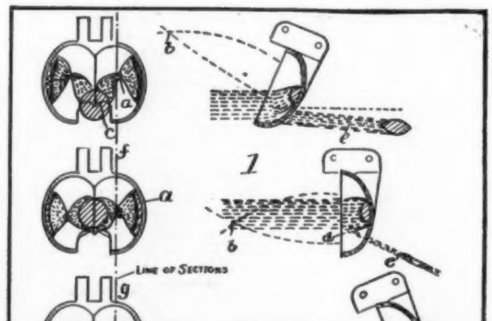


FIG. 6.—SHOWING PATH OF WATER IN AN ELLIPSOIDAL BUCKET IN ITS DIFFERENT POSITIONS.

Note point of disturbance at *a*, flat impact and division in two planes at *c*. Nodes of discharge, *b*; leakage of pressure water, *e*.

read by Messrs. J. E. Stead and A. W. Richards at the Barrow-in-Furness meeting of the Iron and Steel Institute, which was recently held. If the results of the treatment recommended by Messrs. Stead and Richards are as satisfactory as they anticipate when carried out on a commercial scale, there would seem to be considerable probability that ordinary steel of the hardness suitable for crank-shafts, connecting rods, and all other important engine parts, will be rendered twice or three times as durable as it usually is at the present time. The Stead and Richards process is of extreme simplicity. It merely consists in re-heating steel to a certain point. It has been described in the columns of the daily press in connection with the Iron and Steel Institute meeting, but the essential features of the new treatment have not generally been made very intelligible. The reason is this: All large masses of steel that are subjected to subsequent forging by rolling down or other means are heated in what is known as the mill furnace before forging. If they are overheated in this furnace, the metal becomes what is commonly known as "burnt," and its properties are so much destroyed that it often falls to pieces in the rolls. The heating which is required for this, however, is, according to Messrs. Stead and Richards, in the neighborhood of 1,200 deg. C. The remarkable discovery made by these gentlemen is that steel that has been thus destroyed by overheating can not only be restored to its original condition, but can be considerably improved by heating up after cooling to 850 deg. or 900 deg. C. It appears that the temperature must not be raised much above the latter point. What is still more remarkable, however, is that steel which has become crystallized through use can be brought to what is really an improvement on its original forged condition by the same treatment. Engineers are commonly familiar with the appearance of a fractured crank-shaft or connecting rod. Under nearly all circumstances it is exceedingly crystalline in structure; in fact, it resembles in appearance "burnt" metal. The cause is as follows: Forging rolls out and superposes the crystals forming the metal and gives the satiny-looking structure associated with good metal. Constant jarring while in use restores the crystalline condition that characterized the metal before forging, and at the same time reduces its strength. It is after this process has taken place that fractures are likely. Hitherto it has been thought impossible to bring metal that has become crystalline by use back to the fine-grain condition by any other means than re-forging. Messrs. Stead and Richards have, however, made experiments with metal rendered crystalline in this way, and have found that their treatment completely restores the fine-grain structure, at the same time increasing the tensile stress and power of resisting strain to, in many cases, more than twice what the metal previously presented at its best. Somewhat analogous results have been previously obtained with mild steel, but Messrs. Stead and Richards appear to be the first to have successfully applied treatment of the kind to steels of the hardness needed for crank-shaft construction and similar purposes. The extreme simplicity of the process is one of its greatest recommendations.

THE RELATIONS BETWEEN SCIENTIFIC RESEARCH AND CHEMICAL INDUSTRY.*

THE particular branch of science with which I have been asked to deal at this meeting of university extension students—viz., chemistry—is perhaps better calculated to illustrate the intimate connection between scientific research and *productive* industry than any other subject. I emphasize the term *productive* industry because it is desirable to distinguish between productiveness and trade, i. e., buying and selling. With the latter I have nothing to do beyond pointing out the very obvious principle that, without something to buy or sell, there would be no commerce, and consequently productive industry must be put into the first rank. Now chemical products of various kinds are absolutely indispensable to all civilized nations. You may remember that many years ago Lord Beaconsfield said that the state of trade could be gaged by the price of chemicals. A writer in the North American Review in 1899 published an article in which he laid it down that the nation which possessed the best chemists was bound to come to the forefront in the struggle for industrial supremacy. Of course, "there is nothing like

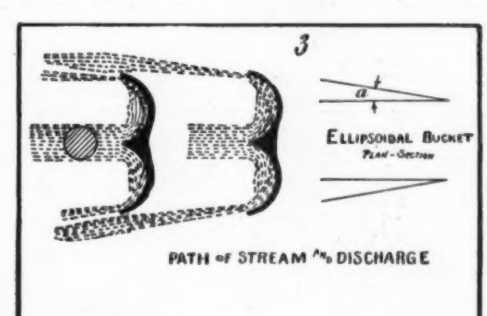


FIG. 7.—PLAN VIEW OF BUCKETS SHOWING THE THIN DISCHARGE OCCURRING FROM THE PELTON AND SMOOTH FLOW IN THE CAVITIES.

leather," and I am bound to agree with him. Had he

* A lecture delivered at the University Extension Meeting at Oxford on August 3, by Prof. Raphael Meldola, F.R.S.

been an engineer or an electrician he might perhaps have said the same for mechanical or electrical engineering. At any rate, it is perfectly safe to generalize his statement, and to declare that the nation which possesses the most highly trained technologists is bound to take the lead.

In so many ways does chemistry come into contact with nearly every branch of industry that it is difficult to know where to draw the line in giving actual illustrations of the industrial results achieved through chemical research. It is not possible logically, for example, to distinguish between the results obtained through research directed toward the solution of a particular industrial problem and the results obtained as by-products in the course of purely scientific investiga[illegible] has been advanced, and always will be advanced, by both methods. Bearing in mind also that chemistry, in its widest sense, is essentially the science of matter—at any rate until the physicist has electrified matter into his own domain—it is evident that we are concerned not only with the production of useful materials for direct consumption, but also with the production of materials required in other industries. Thus chemistry affects engineers through the metals, cements, and other materials used for constructive purposes, and through the fuels used as sources of energy; it affects the agriculturist on account of the relationship between the growing plant and the composition of the soil, as well as through the relationship between the composition of crops and their value as food-stuffs; it supplies materials for the pharmacist, for the manufacture of pottery, glass, and soap, for the paper maker, for the dyer and color-printer, for the bleacher, tanner, brewer, and spirit distiller; it furnishes the explosives used in modern warfare, and it supplies photography with all the materials necessary for the practice of that art. Among later developments it may be claimed that the modern science of bacteriology is the outcome of chemical research and the manufacture of antitoxins—the industrial result of this science—has until quite recently been in the hands of the chemical manufacturers. I may remind you also that many important products such as sodium, aluminium, phosphorus, calcium carbide, caustic soda, and chlorine are manufactured by electrical processes, so that the demand for these products has given an impetus to the development of applied electricity.

It is obviously impossible in view of the enormous range of industry in which chemistry is directly or indirectly concerned to do more on the present occasion than take a cursory glance at a few of the more striking cases illustrative of the connection between research and industry. As an example of the creation of an industry through research directed toward a special end, attention may be directed to the manufacture of optical and other glass at Jena. The history of this branch of manufacture, and the results achieved, have been fully described by Dr. Hovestadt in a work published three years ago, and of which a translation, by Prof. and Miss Everett, has been recently published in this country. I must refer you to this work for full particulars. The physical requirements to be complied with in order to produce the most perfect glass for the construction of lenses for optical instruments had long been known, and many attempts had been made to realize these conditions in practice. A visit to the international exhibition of scientific apparatus in London in 1876 led Prof. Abbe to direct attention once again to the fact that the future perfection of the microscope lay with the glassmaker, and in 1881 he, in conjunction with Schott, commenced a set of experiments having for their object the production of a series of glasses of known composition, the optical properties of which were concurrently determined by measurements made by Prof. Abbe. The experimental meltings were enlarged in scale the following year, and an experimental laboratory established for the continuation of the work at Jena. A chemist was added to the staff, and thus there were co-operating in this industrial research a glassmaker, a chemist, and a physicist. Before the end of 1883 the results had been so far successful that the Jena laboratory was in a position to make known to the world the processes for the "rational manufacture of optical glass." At this stage the experimenters were persuaded to put the results of their labor into practice, and the instrument makers, Messrs. Zeiss, having joined in, the Jena glass factory for producing optical glass on the commercial scale was established toward the end of 1884. In the first catalogue published by the Jena works in 1886, we are told that forty-four optical glasses, nineteen being new in composition, were included. By 1888 the undertaking had been so successful that a supplementary catalogue was issued containing twenty-four additional glasses, of which thirteen were new, and in 1892 a second supplement announced the manufacture of eight more kinds of glass, of which six were new. Consider what this piece of work, prompted by science, fostered by the state, and carried out by a university professor in conjunction with a technologist has done for German industry. In the early stages of the experiments, before commercial results had been obtained the experimenters were subsidized by the Prussian Education Department and by the Prussian Diet with a wise forethought which subsequent events have amply justified. Need I remind those who have come here to hear about bacteriology from Prof. Sims Woodhead how that science has advanced *pari passu* with the perfecting of the microscopic objective? The Zeiss instruments are now world-renowned, for it is obvious that a command over the processes for making glass with any particular optical properties that might be desired would enable the instrument maker to produce lenses suitable for other purposes, such as telescopes, field-glasses, photographic cameras, etc. I am afraid to dwell too much upon the perfection of the lenses of the Jena instruments because I lay myself open to the charge of holding a brief for a particular firm. If you want to know more fully what this optical glass industry has done for Germany, I refer you to the report on instruments of precision published in connection with the German exhibit at the Paris International Exhibition of 1900. As a further outcome the study of the properties of glasses of known composition in connection with their thermal and electrical behavior has led to the manufacture of glass especially suitable for making thermometers, as also for electrical insulation, for the construction of the vacuum tubes used for producing Röntgen rays, and for the vessels employed in chemical laboratories. In brief, the manufacture of the finer kinds of glass has been placed upon a strictly scientific footing as the outcome of scientific research.

The next illustration which I propose to make use of refers to the applications of chemistry to agriculture. The growing plant, as you are aware, requires food for its growth just as much as the growing animal. Take an extreme case, and consider the size and weight of an oak tree as compared with the acorn from which it arose. This enormous accumulation of matter represents the assimilation of gaseous food in the form of carbon dioxide from the air through the leaves, and of water and nitrogenous and other mineral matter through the roots. It was the great German chemist, Liebig, who first established this broad principle of plant growth by systematic experiments upon various crops, and his results were given to the world in a work published in 1840, the English edition, edited by Lyon Playfair (afterward Lord Playfair), bearing the title "Organic Chemistry in its Applications to Agriculture and Physiology." Perhaps few students consult this work now, but it was, strictly speaking, epoch-making on its appearance, because it brought the chemist into direct relationship with the farmer, and the consequence has been an enormous increase in the food-raising capacity of the soil. It is not necessary to inquire closely here into the motives that prompted Liebig's investigations—whether his work comes under the category of scientific researches directed toward a practical end, or whether he began with a desire of ascertaining abstract truth in the first place, and then found that his results were capable of practical application. It is quite immaterial from the present point of view how this work originated, because we are considering only the bearing of the results upon industry. It is evident that if a growing plant requires certain elements, such as potassium, sodium, phosphorus, nitrogen, calcium, magnesium, sulphur, chlorine, iron, etc., and if the soil by previous crops has been exhausted of some of these elements, it will not be possible to raise subsequent crops on this impoverished soil unless the necessary elements are supplied. In other words, the requisite elements must be added, and added in the form of compounds which the plant can make use of. Thus the great industry of crop-raising, and as connected therewith the feeding of farm stock, was shown to depend ultimately upon the chemical composition of the soil, and the manufacture of artificial manures or fertilizers has been the practical outcome of Liebig's researches.

Let us consider, further, the industrial results so far as these have influenced chemical manufactures. Prof. Warington can tell you all about the agricultural results. The elements which are most likely to fail, and which, in fact, have generally to be supplied, are potassium, phosphorus, and nitrogen, excepting, of course, in the case of those particular leguminous plants which have developed a special means of fixing atmospheric nitrogen. Chemistry having thus been called upon to supply the agriculturist with compounds containing potassium, phosphorus, and nitrogen, the first development which may be ascribed to Liebig's influence is the Stassfurt salt industry in Prussia, where immense deposits of salts containing potassium were known to exist. Similar deposits are found in Anhalt. The mining of the salts was commenced in 1860, and has proved an immense source of wealth to Germany, the total value of the Stassfurt and Anhalt salts produced down to 1890 being estimated at £11,500,000, and since that time the output has gone on increasing from year to year. It is not necessary to weary you with statistics, but it is important to note how the demand for potassium salts for agricultural purposes has given rise to a great industry, for the natural salts, consisting chiefly of carnallite, a double chloride of potassium and magnesium, and kainite, a double sulphate of potassium and magnesium with magnesium chloride, have to be submitted to various processes in order to separate the constituents, and the Stassfurt salt factories are now supplying Germany, as well as exporting large quantities of potassium chloride and sulphate, magnesium chloride and sulphate, potassium carbonate, caustic potash, etc.

In a similar way the demand for phosphates has given rise to the utilization of every available source of these compounds. Calcium phosphate is found as the mineral apatite, a double calcium phosphate and chloride or fluoride occurring in vast deposits in America, and also in a less definite form in Canada, the West Indies, France, Belgium, and Germany. In this country calcium phosphate occurs in the form of coprolites, supposed to be the excreta of extinct saurians, in Cambridgeshire and elsewhere. All these natural phosphatic mineral deposits are mined, and have become valuable assets to the countries possessing them. The conversion of the minerals into a form suitable for the nutrition of crops is a branch of chemical industry involving the use of sulphuric acid for the conversion of the natural phosphate into the more easily assimilable form known as superphosphate. The greater part of the world's output of natural phosphates finds its way to Germany to undergo this treatment, the annual consumption of artificial manure in that country being estimated at something more than two million tons at a cost of about £5,000,000. The mineral portion of the bones of animals, as you are no doubt aware, also consists largely of calcium phosphate, and before the mining of the mineral phosphates the conversion of bone ash into superphosphate was carried on on a very large scale. Bone ash is supplied now in large quantities from South America, but not much is converted into superphosphate, as the bones, after removal of the fat and the size (for glue), are capable of being finely ground, and are available for manure in this form.

Here is surely a romance of chemistry! The phosphates contained in the vegetation of the South American pampas go to build up the bony framework of the cattle which graze thereon. The skeletons of these beasts ultimately supply, let us say, the growing crop of a beet sugar manufacturer in Germany with phosphates. The phosphates picked out of the soil by South American vegetation concentrate in the bones of cattle, and are then sent into circulation in German beet. Or, even more striking, the phosphates accumulated by the great lizards of a remote geological age are now circulating through growing crops. This circulation of matter through the intervention of the living organism is an every-day story to the chemist. To our greatest poet apparently it was also known:

"Imperious Cæsar, dead and turn'd to clay,
Might stop a hole to keep the wind away;
O, that that earth which kept the world in awe,
Should patch a wall to expel the winter's flaw!"

But we must descend from romance to reality. The deposits of sea birds also contain phosphates derived from the fish upon which they feed, and these deposits often accumulate in such large quantities as to make them available for agricultural purposes. Under the name of guano, immense quantities of this material, which contains both phosphates and nitrogenous matter, are exported from Peru. There is subject-matter for philosophizing here, also, about the circulation of phosphates from marine organisms through birds into growing crops, and so forth, but time will not admit of many side disquisitions if I am to keep to my text. As another source of phosphate, it is of interest to know that the basic slag obtained in the Thomas-Gilchrist process of making steel is now largely used, so that the work set going by Liebig has, among its latest developments, led to the utilization of a waste product of the steel industry.

Excepting in the case of leguminous plants, which are capable of utilizing atmospheric nitrogen by a process which it does not come within my province to explain, the ordinary source of nitrogen for growing plants is a soluble nitrate, and if the soil is poor in such salts, they must be supplied either directly or indirectly through the salts of ammonia, which are converted into nitrates in the soil by bacterial action in a way that nobody is better able to explain to you than Prof. Warington. The great natural deposits of sodium nitrate which occur in Chile and Peru supply practically all the nitrogen applied to the soil in this form for fertilizing purposes. With respect to ammonia, the destructive distillation of coal for the manufacture of gas and tar products, or for the production of coke, furnishes practically all the salts of this base required for agricultural and other purposes. The vital importance of assimilable nitrogen to growing crops has led the chemist also to study methods for the fixation of atmospheric nitrogen so as to render this element available for such purposes. It has long been known that nitrogen and oxygen can be made to combine under the influence of the electric spark. This, as you may remember, is one of the methods used by Cavendish in his classical researches on the composition of the air, and it was used also by Lord Rayleigh to separate atmospheric nitrogen from argon. Sir William Crookes has shown that the combustion can be brought about by the electric flame with such facility as to render the production of nitrite and nitrate by this process an industrial possibility, and the manufacture has actually been started in America by utilizing the Falls of Niagara for the generation of the necessary electric power. Still more recently it has been found by Caro and Frank that when lime and coal are heated in the electric furnace, the calcium carbide fixes atmospheric nitrogen to form a compound known as calcium cyanamide, and this decomposes in the soil with the liberation of ammonia, so that the nitrogen of the air is thus rendered available for plant nutrition by an electrochemical process. The manufacture of this "Kalkstickstoff" is in the hands of the electrical engineering firm of Siemens & Halske, in Berlin.

There has been no straining of facts on my part in this sketch—necessarily brief—of the industrial results of Liebig's work. The establishment of the fundamental truths was a piece of pure scientific research. Had it not been made known by the irrefragable proofs furnished by scientific method that such and such elements were essential for plant growth, the mineral resources of the earth would have remained unused for this purpose. The minute percentage of nitrogen locked up in the fossilized vegetation of the Carboniferous period would never have been isolated in the form of ammonia and applied to the soil for the nourishment of the crops raised by the present day agriculturist. The successful cultivation of the beet as a source of sugar has been made possible by this knowledge, and it may be of interest to add that the further scientific study of the cultivation of that root in Germany has led to the yield of sugar being increased from 5¾ to 13 per cent during the period commencing about the year 1840, and ending at the present time. The economic result of this industry upon our own sugar-growing colonies is a fiscal question which does not come within the province of this address.

Equally instructive as illustrating the connection between scientific research and industry is the production of alcohol and other valuable products through the agency of living organisms. The spontaneous conversion of saccharine solutions, such as the juice of the grape, into solutions containing alcohol, with the concurrent development of gaseous carbon dioxide, is among the earliest recorded observations in applied organic chemistry. The various theories which were from time to time advanced to explain what is called "fermentation" are now of historical interest only. It is to the researches of Pasteur that we are indebted for the placing of the fermentation industries on a scientific foundation. This illustrious chemist, who as far back as 1860-62 had successfully disproved the so-called "spontaneous generation" by showing that the ordinary air was always charged with living germs, turned his attention to the diseases of wine, with the object of assisting an industry of great national importance in France. His "Etudes sur le Vin" was published in 1872. A greater work—the great classic of the science of fermentation—appeared in 1876 under the title "Etudes sur la Bière." In this work it was definitely proved that the transformation of sugar into alcohol is a biochemical change; that the yeast which produces this change, and of which the organized nature had long previously been suspected, is, in fact, a low form of vegetable life allied to the fungi, and that it multiplies and grows at the expense of the sugar and other materials contained in the fermenting liquid, the alcohol and carbon dioxide being the products of its activity. It is now known, through

the work of Buchner, that this chemical transformation of sugar into carbon dioxide and alcohol is the result of interaction between the sugar and a certain definite substance—an unorganized ferment—which is formed by the living yeast cell, and which can do its work independently of the cell in which it originated.

The scientific development of the fermentation industries followed from this and other works of Pasteur's. The names of those who have taken part in these later developments are numerous and illustrious, but want of time prohibits a detailed survey of this most fascinating chapter of biochemistry. The leading idea that the formation of alcohol is a biochemical process depending upon certain organisms, or, as we may now say, upon the products of certain organisms, carries with it, as a necessary consequence, the conclusion that the industrial production of alcohol—whether for brewing or spirit distilling, or for the chemical manufacturer—is not an empirical or rule-of-thumb operation depending upon unknown conditions, but a definite chemical change produced in a definite way by a definite organism (yeast), and just as much under control as any other chemical operation. The chemist and the brewer have thus also been brought into association. The recognition that definite chemical transformations can be effected by microscopic forms of life, which resulted from Pasteur's studies in wine and beer, has had such far-reaching consequences that it is impossible to overestimate the importance of this work for the well-being of humanity. I should be encroaching upon the domain of Prof. Sims Woodhead were I to do more than remind you of the growth of that modern science—the most humanitarian of all the sciences—bacteriology, out of this fundamental conception. Keeping to the main topic of industrial results, one outcome has been, as I have said, to bring the operations of the brewer under scientific control. The organism, the yeast introduced into the vat to induce fermentation, must undergo careful microscopic examination to see that it contains no deleterious organisms, i. e., no organisms which would give rise to products other than alcohol. The water used by the brewer must be analyzed to ascertain whether it contains the necessary mineral constituents for the nourishment of the yeast, because this plant is subject to the same conditions of growth as any other plant. Instead of obtaining its carbon from carbon dioxide, however, it can utilize sugar for this purpose, and it decomposes the sugar into carbon dioxide and alcohol in the way indicated.

The recognition of yeast as a vital chemical reagent which is apt to contain impurities in the form of wild or stray organisms which may damage the contents of the brewing vat, has led further to the introduction of the process of brewing by what is known as "pure culture yeast." This industry, of which the home is chiefly on the Continent, depends on the use of a yeast cultivated in the first place from a single cell of some particular species or variety or race by methods similar in principle to those adopted by the bacteriologist, the cultivation being carried on from generation to generation in carefully prepared solutions containing the necessary nutrient materials, sugar, nitrogenous matter, mineral salts, etc., and previously sterilized by heat so as to destroy every other form of life. The brewer can now be supplied, as the outcome of a series of brilliant investigations by Hansen, of Copenhagen, to whom he is indebted for this purification of the biological foundation of his industry, with a cultivated yeast as pure in strain as a pedigree horse or a particular breed of dog—a yeast which, by virtue of its purity, can be depended on for giving constant results in the brewing vat. This is another illustration of the relationship between research and industry.

Consider, in the next place, the sugar which the yeast decomposes by virtue of its zymase. In an ordinary brewing operation the liquor which is fermented is not supplied in the first place with sugar as such, but the starch contained in the barley grain is ultimately broken down, as chemists say, into sugar by virtue of certain processes which I cannot stop to explain. But the broad fact is that yeast cannot feed upon starch, but only upon sugar, and, in fact, only upon certain kinds of sugars, and the starch which is stored up in the barley is the raw material which ultimately supplies the necessary kind of sugar. So that starch, which, as you know, is a substance very widely distributed in the vegetable kingdom, can be extracted if necessary from the seeds or tubers which contain it, and converted into sugar by chemical processes, and then used for the production of alcohol. An important industry is flourishing in Germany at the present time for the production of alcohol from potato-starch. In Berlin a few weeks ago we were shown over a large establishment entirely devoted to the fermentation industries, and potato spirit and other products from the potato were the most conspicuous features of the exhibition. Now alcohol is a substance of great importance for chemical industry in many directions, and its inflammability makes it valuable as a fuel, so that the problem of the cheap production of alcohol is worthy of the serious attention of investigators. It is interesting to contemplate the period when our natural sources of fuel, coal, and petroleum are all exhausted, and when we may have to fall back upon the vital activity of a lowly form of vegetable life to supply us with liquid fuel. Scientific research has helped here, also, to call a new industry into existence, because the cost of alcohol, like that of any other chemical product, is obviously dependent upon the yield, i. e., upon the quantity obtainable from a given weight of raw material. I must claim your indulgence while I trace in brief outline one of the most beautiful of the modern industrial developments of the principles of fermentation.

It had long been known that in Java an alcoholic beverage, known as arrack, was prepared by fermenting molasses with a peculiar ferment prepared by a special process from rice. From what has been previously said, you will understand that the starch contained in rice is not, as such, available for direct alcoholic fermentation. A detailed scientific investigation of the starch-fermenting materials used in Java and elsewhere in the Far East has revealed the fact that the ferments owe their activity to the joint action of two out of several different organisms which are contained in them. One of these is a mold fungus which has the property of saccharifying starch, i. e., breaking it down into sugar, and thus rendering it available for the growth of the other organism, which is a yeast capable of exciting alcoholic fermentation in the usual way. Now the principle revealed by the scientific study of these eastern ferments has been developed into an industrial process for producing alcohol from starch of any origin, such as from maize, rice, potato, etc. The operations, in the briefest possible terms, consist in saccharifying the prepared starch by a pure culture of mold fungus, and then fermenting by means of yeast. The problem of increasing the yield of alcohol has thus been solved; not only is the spirit obtained in more concentrated form, but the actual percentage of alcohol furnished by a given weight of starch is much greater than has ever been obtained by any of the older processes of fermentation.

(To be continued.)

APULIA.

THE southeastern region of Italy, where the energetic prime minister, Signor Lanardelli, has recently been investigating the miserable condition of affairs (in some cases exploring the district in a bullock cart), seems cut off from the rest of the peninsula in a curious manner by differences in race, manners and customs, and to some extent in the matter of language. In art the province of Apulia has always been widely distinguished from the more favored north and west of Italy, and chiefly by the absence of that remarkable sense of the finer æsthetic character which seems a part of the Tuscan nature.

The mountain ranges which extend southward of Rome divide the Neapolitans proper of the Mediterranean shore, with their imported tastes for the arts and luxuries of life, from their more indolent and squalid neighbors on the Adriatic. Naples and its adjacent district probably owes all that it possesses of an artistic character to the influence of Rome and the powerful foreign races which have successively tyrannized over the mixed population of the largest city of the Mediterranean. But the luxury of the capital has scarcely penetrated into the outlying districts of Apulia, the Basilicata, or Calabria. In classic times Apulia formed part of the vast area known as Magna Grecia, and at the present day a very remarkable similarity still survives in many respects between the far south of Italy, Greece and the Archipelago, and Cyprus. For centuries this extensive area of the eastern Mediterranean has been occupied by a race which is popularly described as "Greek," but which has in reality very little claim to be descended from the ancient Hellenes. The language of the ancients survives in the modern "Romaic," owing to the singularly conservative nature of Levantine Christianity, but beyond that tie with a remote past very little else remains from classic times. Under the *ægis* of a common religion opposed to Mohammedanism on the one hand and the vigorous Christianity of the West on the other, the strange mixture of Albanians, Sclavonians, Anatolians, and Eastern Neapolitans seems to have adopted a common language and a common form of art during the Dark and Middle Ages.

To a student of the history of architecture the chiefly interesting feature of this district is the presence of a distinctly "Gothic" or pointed arch style which prevailed during the thirteenth and fourteenth centuries —the period of the contemporary "Gothic" of Western Europe—and may be said still to survive in certain places.

Architecture in Apulia of the centuries immediately preceding the thirteenth can hardly be studied in any surviving examples with the exception of those of a purely ecclesiastical sort. Few, if any, domestic or civic edifices remain of an early period north of the Alps—and even in Italy they are extremely rare. During the long artistic interregnum between the ancient world of classic times and the revival of the arts and sciences in the early Middle Ages, a singular disregard for the domestic arts and luxuries of life seems to have prevailed. Such few traces as we possess of the architecture of the dark ages are usually in the form of church buildings, with little pretension to design, bedizened with very meretricious and often meaningless ornament. The contemporary feudal castles have little about them to suggest an architectural style. In Apulia the Romanesque castles and churches resemble those of other countries, and the latter are only remarkable for their large numbers.

With the advent of the thirteenth century the invigorating influence of the pointed arch style made itself felt all over the civilized world, and Apulia was not behind the rest of Europe in displaying a particular development of the fashionable art. This particular development may, perhaps, be classified as a section of the pointed-arch or "Gothic" style common to Magna Grecia and the Levant.

The "Gothic" art of Cyprus is being exhaustively described and illustrated in a magnificent French publication, the third volume of which is still in the press.* The remarkable development of "Gothic" under the Lusignan kings in this eastern island may perhaps be attributed to influences which erected Cyprus into a species of bulwark against the Mohammedan encroachment of the period, and induced the Cypriots, for obvious reasons, to adopt a style so specially characteristic of western civilization. In the Morea and the ancient dukedom of Athens the once flourishing principalities founded by northern adventurers are in a similar manner still recorded by innumerable "Gothic" monuments, and the influence of the style may be detected even in modern days. But in Apulia the style is still more at home, although its palmiest days were doubtless at a time when the harbors of Brindisi, Bari, and Taranto were crowded with shipping and transports for the crusading armies of Europe.

The local variations in the great all-pervading pointed arch style of mediæval Europe depended chiefly on climate, and still more on the building materials at hand. In Apulia—as all over the south of Italy—architecture has been very much handicapped by the wretched character of the local stone and the absence of brickwork. *Tufa* is almost the only building stone procurable, and, although good enough for mere walling, is, from its rough and uneven texture, unsuitable for any artistic expression in carving or molding. Not until the days of Michelangelo and the pseudo-classic school did such materials play any part in architectural designs as "rustications" or other more or less meretricious aids to a ponderous magnificence. The southern Italians of the Middle Ages built their houses, castles, and churches in the prevailing "Gothic" style, but always with the intention of covering up the masonry with gypsum and limewhite both inside and out. The climate admits of such a system, and the local materials oblige it; for decorations they relied upon imported marble or stone, and still more upon the inevitable brush-work of the mural painter.

The style of the "Gothic" buildings of Apulia—ecclesiastical and secular—clearly belongs to the Tuscan school of Italian art. This is remarkable considering the immense influence of Venice, not only on the opposite coast of the Adriatic, but in the comparatively far-distant Morea, Crete, and Cyprus. To pass over from the Dalmatian coast of the Adriatic, with its quaint old Venetian cities of Sebenico, Spalatro, Ragusa, etc., to the opposite side (in places visible with the naked eye from one side to the other) affords a remarkable contrast in every characteristic. The narrow *calle*, the ogee-headed windows opening on to little marble balconies, which meet the eye at every point in the crowded intricacies of a Venetian town; the slender campanili, crowned with the short conical spire of the lagunes, are nowhere to be seen in Apulia. On the contrary, the wide straggling streets of an Apulian town lined by low, flat-roofed houses, with little or no architectural pretensions; the comparatively low church towers, built in stories of width diminishing with their height; the all-pervading presence of whitewashed plaster, impress the architectural student with a truly Levantine aspect. At the same time, the tall narrow churches with wooden roofs and deeply splayed windows, the wide segmental arches over doorways and in cloistered arcade, are distinctively Tuscan, and more reminiscent of S. Croce, Florence, than anything to be found in Venice. This striking contrast between the two sides of the Adriatic may be attributed partly to the greater frequency of earthquakes in South Italy, necessitating a one, or, at most, two-storied mode of building; but the presence of the Tuscan details of architecture can only be due to the immigration of northern masons, possibly accompanying such materials as were imported for decorative purposes. The spread of the Franciscan order, which seems to have so greatly influenced the growth of the "Gothic" style during the thirteenth century in other parts of Italy, must also have had a share in introducing the northern character. As has been shown in a previous article in the Builder on Franciscan Architecture (September 27, 1902), the evolution of the "Gothic" style is intimately associated with the foundation of the great orders of friars, and in Naples itself one of the largest of friars' churches ever built (Santa Chiara) is still *en évidence*. This immense edifice was unfortunately too much transformed during the sixteenth century with plaster and painted decorations to allow its mediæval character to survive or its vast proportions to be appreciated at the present time.

The "Gothic" churches of Apulia are but little known, and the subject invites an extensive monograph such as M. Enlart has so ably carried out for the cognate architecture of Cyprus. At the same time, some of M. Enlart's arguments for a purely French origin of the Cyprus style would, perhaps, receive modifications if the mediæval art of the far south of Italy had received that attention which it certainly merits. For instance, the church of S. Domenico, Taranto, a building of the usual Tuscan plan, with short, aisleless nave side chapels and wooden roofs, has an interesting façade, the great doorway of which is almost identical in detail with the west front of the cathedral of Famagusta, Cyprus. The same richly molded arch is covered by the same elaborately carved dripstone ornamented with large acanthus leaves. The way in which the plinths and moldings are twisted into steps and rectangular panelings also betrays a kindred masoncraft. The Taranto example only differs from the Cyprus churches in having a somewhat older and more decayed appearance. Another example of the Tuscan plan and method of construction carried out with the proportions and details characteristic of Cyprus is the Abbey of St. Maria della Guistizia, a twelfth-century building situated a short distance to the west of Taranto. The Church of St. Paolo, Brindisi, exhibits a similar combination of Eastern and Western "Gothic," the tall lancet windows of the Tuscan wood-roofed church have traceries and moldings suggestive of Cyprus and its internal proportions would harmonize with such details if it were ceiled with the Cypriote stone vaulting.

The domestic building of Apulia is much more distinctly classified as Levantine than the churches. The flat-roofed houses are usually, in part, constructed with the domical vault of the East in which the arris, or "suk," as it is called in Syria, of the vaulting, rises much higher than the line of curvature against the walls—and forms, in fact, a species of four-sided dome. In the older buildings this method of construction seems to have been adopted for both stories of the ordinarily low built houses. Comparatively small vaulted rooms are a natural result of such construction, and the most characteristic feature of Apulian towns is the small mediæval house, the lower story used as a shop or entrance, the upper vaulted room toward the street having a front wall formed of a wide arched recess, which forms also a partial cover to a balcony carried on molded corbels.

Palaces or imposing buildings are comparatively rare in Apulian towns. The mediæval art of the northern cities fostered by aristocratic families or civic institutions is nowhere represented. On the contrary the towns are made up of small traders' houses clustering under the shadow of an inevitable castle, the representative stronghold of a more or less alien government.

Castles are, indeed, the very commonest features of the Apulian landscapes. Hardly a horizon comes into view on which some ruined fortalice does not appear to remind the modern traveler of a romantic past, when this country would seem to have been the very center of warlike enterprise, and the much fortified frontier between East and West. The splendid triangular fort-

* "L'Architecture du Moyen Age au Chypre," par M. Enlart.

ress of Oria, the home of the famous Doria family, is one of the most beautiful of mediæval castles, as it stands proudly predominating the watershed between the Adriatic and the Gulf of Taranto. The castles built by Emperor Frederick II. have a special interest, and several of them are particularly well preserved, and of a later date those remodeled by the Emperor Charles V. are of the greatest importance in the history of military architecture.—The Builder.

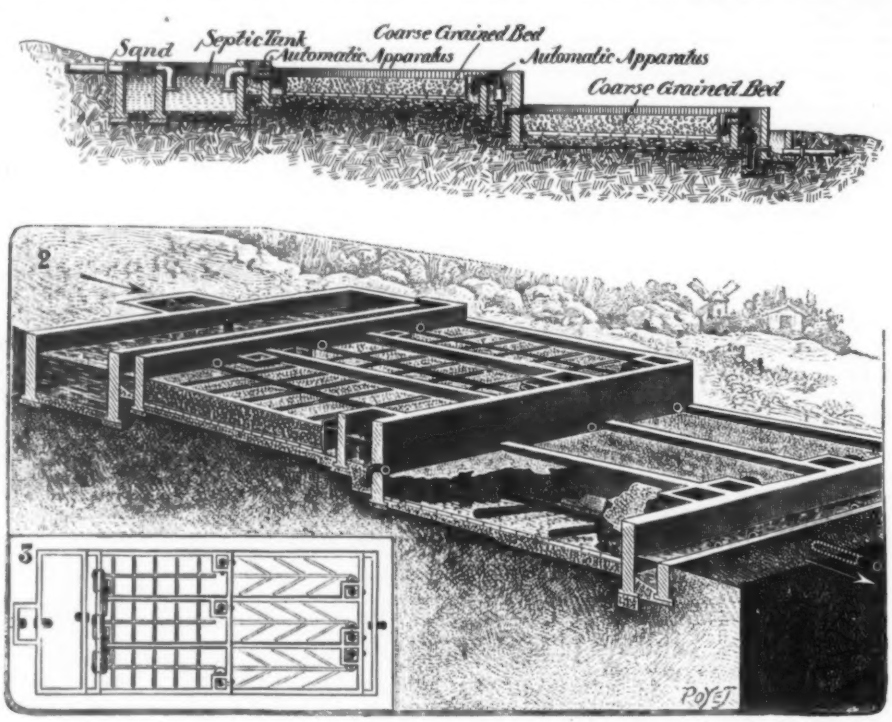
BIOLOGICAL PURIFICATION OF SEWAGE WATER.

THE word "biological" is the correct term to employ in connection with a method which has been several times alluded to in these columns, and which we now desire to describe, since the process calls in the aid of living organisms—of bacteria, for the treatment of residual waters in general and for rendering the various substances that they contain assimilable by the soil.

The city of Paris, as well known, adopted the practice of simultaneously directing all filth to the sewer and distributing the sewage water over the soil. But it was found, somewhat late, that such treatment has numerous drawbacks and that it salivates the distributing grounds with water holding myriads of nocuous germs in suspension. What caused a belief in the efficacy of the distribution of sewage water, and what might be called purification by vegetation, were some experiments that were in reality the first manifestations of bacterial purification. These curious experiments were made at the Lawrence agricultural station by Mr. Hiram Mills. It was found that the disappearance of the organic matter contained in the sewage water did not occur through continuous filtration through the earth, and it was at first thought that it was due to the plants that grew in the soil and assimilated the organic matter. In reality, the rest that had to be allowed to the plants between the periods of purification was not necessary to them, since they are incapable of effecting the assimilation in question, without a previous decomposition of the water, but rather to the soil which needs to be aerated in order that the living organisms that it contains may devote themselves to the oxidation of the organic matter. The plants merely interfere with the phenomenon and render it slower, since, upon the best distributing grounds under culture, it is possible to destroy but about 40 tons of such matter to the acre, while upon soil prepared in such a way as to present perfect permeability, the corresponding quantity exceeds 450 tons. Such are the results obtained as long ago as 1887 at the Lawrence station, where the artificial soil could not be considered as a true soil, in the sense that we usually understand the word, since it was formed of sand and baked clay, and might just as well have been composed of scoriæ or clinker, the important point being that it shall be permeable and absorbent. In fact, it should not allow the water to pass so freely that the microbes shall not have time to play their part. And yet it is necessary that it shall afterward permit of the rapid escape of the water in order that the air may penetrate its mass and bring oxygen to the second series of microbes, of which we shall speak further along, and of which the rôle is exceedingly important.

It is a question, upon the whole, in the purification of residual waters, of bringing the organic matter that the latter contain to the state of mineral matter. Now, as M. Calmette, the learned superintendent of the Pasteur Institute, of Lille, has recalled, and as also Mr. Leonard P. Kinnicutt has stated before the American Association for the Advancement of Science, sewage waters (to use this term in its widest sense) contain two principal groups of substances that have to be decomposed: ternary substances, such as cellulose, sugar and starch that are found in the residue of vegetables, paper, linen, etc., and then quaternary substances, such as all nitrogenized matters, debris of meat, albumens, dejections, etc. Some of these are converted into mineral elements by anaerobic microbes, and others become liquefied and converted into ammonia, and finally the nitrates appear. Here, it is necessary to call in the aid of aerobic microbes. This is equivalent to saying that it is necessary to put the sewage waters successively into the conditions in which the two armies of minute workers may best live, and, consequently, perform their rôle in the most complete and rapid manner.

It is well known among specialists that we owe much to Schloesing, Müntz, Muller, and Marié-Davy for our knowledge of the action of these bacteria, and that Mourras was inspired by true principles when he devised his automatic manure basin. At present, it is especially in England, and also to some extent in the United States and Germany, that the biological method of which we have just made known the basis is currently and satisfactorily applied. A beginning was made by having recourse to the Dibdin bacterial beds, composed of a layer of coke covered with pebbles. But there was but one kind of bed, and that rapidly became filthy, and it was then necessary to leave it at rest in order to permit the aerobic microbes to act. Such intermittent operation is impracticable where the population is such that the sewage water must be purified continuously, and so it occurred to Cameron to treat the water in what he calls septic basins before passing it over the beds just mentioned, and that were thereafter to be devoted to aerobic microbes. These septic basins are somewhat like the Mourras ones. The materials accumulate therein for a sufficient length of time to allow of the development of a goodly number of anaerobic microbes, which render the insoluble matters soluble. The time required for this, however, is not long, since it does not exceed twenty-four hours, and such a period, it will be seen, agrees perfectly with sanitary requirements. When, subsequently, the water treated in this manner goes to the aerobic beds composed of coke, baked clay, and iron dross, it takes but a few hours for it to become freed from all organic matter by aerobic bacteria. It is a mixed system that has been adopted, and that is now known under the name of anaerobic bacterial process with double aerobic contact, the contact beds of this last kind being in reality double, as shown in the accompanying figure. We here see a sand chamber which first receives the water and has only a mechanical part to play. This chamber is normally provided with grates for arresting the heavy and imputrescible matters, stones, metallic objects, etc., which chance to be in the sewage water.



PLANT FOR THE BIOLOGICAL TREATMENT OF SEWAGE WATER.

1. Longitudinal section. 2. Arrangement and piping of the successive beds. 3. General plan.

Of course, large installations may comprise a series of elementary arrangements, of which we have figured but a single type; but the general arrangements are always the same. Upon leaving the sand chamber the water flows to the septic basin. Apropos of this, it may be remarked that there was talk of covering these septic basins in order to keep the thermic conditions constant, prevent the entrance of air, assure a better anaerobic fermentation, and also to utilize the disengaged gases for lighting and heating; but the fact is that as soon as such fermentation is set up, there forms upon the basin a scum, analogous to that of vinification, that sufficiently shelters the phenomena and the bacteria from the contact of the air, while at the same time a certain deposit forms at the bottom of the basin. Moreover, what is a curious thing, at the end of a few months the scum and deposit cease to increase. The disintegration of the ternary substances gives bubbles of gas, which burst in part through the scum. The odor emitted closely resembles that given out by gas works. The water that makes its exit from the septic basin, and which is black and malodorous and contains soluble organic substances, is sent at the end of twenty-four hours to the aerobic beds, which are mostly established upon compact clay 45 inches in depth, and the bottom of which is provided with terra cotta pipes. These pipes, which are not jointed at the extremities, discharge the water that enters them into one collector in common. The bed is formed of scoriæ, which is finer and finer in measure as the surface is approached; and radiating channels assure the distribution of the water in a thin stratum upon the surface of the bed. The filling is assured in one hour by automatic arrangements. The contact afterward lasts two hours, and the emptying is effected in an hour. The operations have to be slow in order to favor the action of the bacteria. Upon coming from the first bed, the water goes to the second, and matters are generally organized so that it may be possible to treat waters constantly, in alternating the periods of rest and operation of the various beds. What is curious to remark is that the beds do not operate well until at the end of a few months after being put in service and after they have become well supplied with bacteria.

We cannot prolong these explanations as to bacterial purification further, but we must at least note that the number of the germs cultivable in the effluent matters from the beds is no more than from five to ten per cent of that found before the treatment. The water is really purified and is no longer subject to alteration, and may be allowed to flow to the river or be employed for industrial purposes. The ammonia that it contains is in a state to be easily converted into nitrate as soon as it absorbs a sufficient quantity of air to undergo oxidation.

This system, then, appears to be eminently practical and effective. It operates rapidly and surely; it permits of purifying thirty-six times more water than does the old system of surface distribution; it does not possess the characteristic inconveniences of the latter, and the cost of installation is not very high.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

ELECTROLYTIC PROCESS FOR EXTRACTING ANTIMONY FROM ITS SULPHURETED ORES.

GIVEN the natural sulphide or sulphuret of antimony, the object of this process is to attract by electricity the antimony to one pole and the sulphur to the other, and this is best done by dissolving the ore in an appropriate liquid.

The solvents best serving the purpose are the various sulphurets or alkaline-sulpho-hydrates, the former having the preference.

Let us, for the sake of an example, examine into what takes place when using the sulphuret or sulphide of sodium Na_2S. When we bring the sulphuret or sulphide of antimony in contact with a solution of this salt, the sulphuret of antimony resolves itself into the state of two sulphur salts, or the double salts of antimony and sodium equally resolvable according to the equation: $Sb_2S_3 + 3Na_2S = 2SbS_3Na_3$, which is the same as sulphuret of antimony+sulphide of sodium= sulpho-antimonite.

Because in this instance we have chosen Na_2S the normal sulpho-antimonite will constitute the greater part of the liquor; with the sulpho-hydrates or other sulphurets, however, we had obtained either a meta-sulpho-antimonite or a pyro-sulpho-antimonite, as the case might be.

It is, however, always allowable to consider that we are to use the electric current upon a salt with a well-defined formula; therefore if we, in the case under notice, plunge the electrodes into the solution and connect them with a generator we shall see the antimony collecting at the cathode and the sulphur at the anode, while the sodium sulphuret will be regenerated and remain in the liquid as is shown by the equation $Sb_2S_6Na_6 = Sb_2 + S_3 + 3Na_2S$.

In order to make the operation continuous it will suffice to add trisulphide of antimony to the solution according as the metallic antimony is deposited at the cathode. It is also proper to remark just here that sulphur gathers at the anode where it first unites with the sodium-sulphide to transform it into a polysulphuret, and this should continue until the maximum of sulphuration being attained, the sulphur deposits itself in its natural state. The period required for sulphuration is distinctly manifested by a polarizing electro-motive force that increases unceasingly, only attaining its maximum efforts when the pure sulphur begins to deposit at the anode, which is otherwise easily explained by the differences between the formative calories in a solid state and a condition of solution.

But this growing poly-sulphuration is a grave inconvenience for, in consequence of the great density of the poly-sulphurets, they diffuse themselves throughout the whole liquid, a progressive diffusion which carries with it, unfortunately, a change in the resistance of the electrolyte and as a result of the electromotive force; in fine, the liquid is constantly changing its composition, which is betrayed by a continued elevation in the difference of potential. To avoid this change in the solvent it has been found advisable to separate the solution by a porous wall, such as parchment, dialyzed paper or asbestos, any of which tends to impede the passage of the liquids, but freely allow the ions of sulphur to pass to the chamber containing the anode, and when they have reached it, there to remain until they are either dissolved or precipitated.

To hasten or facilitate the precipitation the used-up electrolyte is replaced by a solution of caustic soda; on the other hand one may reduce the compartment containing the anode to very modest proportions in order to reduce the volume of liquid contained therein, and thus the sooner obtain the deposit of pure sulphur, dividing an electromotive force that remains constant at about 2 volts, for the composition of the liquid does not vary now, is the one characteristic of the process without which it is impossible to obtain sulphur rapidly in its solid state, that is, by a continuous operation.

The sulphide of antimony, employed as the ore, when analyzed showed according to its richness from 5 per cent to 10 per cent of foreign metals, such as iron, lead, copper, arsenic, silver, gold, etc.

The sulphurets or sulphides of iron, lead, and copper are insoluble in the alkaline sulphurets; their separation then is quite natural and these metals will be found in the settlings; as for the arsenic, the gold, the platinum, the sulphurets of which are soluble, it is no difficult matter to avoid their electrolytic deposit by employing a current of appropriate density, which varies, moreover, according to the temperature of the

bath, the concentration of the solvent, the richness in wolfbergsite of the electrolyte, etc.

With a view to extracting them later, the precious metals will be found in the mother-liquor of crystallization of the electrolyte at the end of the operation.

To sum up, and it is one of the main points which the authors have striven to make, by the application of the process just described, we obtain direct from the raw ore a metal chemically pure.

The above explanation being given, for a better comprehension of the system we shall now enter upon some of the details of the manufacture of the electrolyzer.

The ore, if it be poor, is first stamped, then separated by the methods in ordinary use, either upon the round table or the endless platform, and later subjected to mechanical enrichment. It must be borne in mind that nothing would be gained by enriching it too much, the solvent taking it upon itself to leave the excess inert.

The rich or enriched ore is now passed through a granulator, which reduces it to bits small enough to assist the dissolution. The electrolyzer consists of an enlongated wooden trough, with upright sides and ends, lined throughout with cement to protect the wood from attack by the alkalies and at the same time to give assurance of perfect solidity and stanchness.

This trough is divided into two unequal parts by a porous diaphragm, already described, of which the edges are sunken in the cement.

In the larger or cathodic compartment there is an electrode of carbon or of some metal, in fact, a good conductor of electricity, such as copper, for example, upon which to deposit the antimony. The anode, on the contrary, must be of carbon and not of a metal, which would run the risk of combining with the sulphur. The two electrodes are now brought as closely together as practicable, so as to overcome as far as possible the resistance offered by the bath; they should be suspended some distance from the bottom to be well clear of the settilings, upon arms of cast-glass, extending out at right angles from the vertical walls and screwed into the wood; two other similar glass arms should be provided which shall sustain a perforated stoneware pot containing the granulated ore.

This pot should be placed at the higher part so that the heavier liquid which forms from the dissolution of the ore may tend to descend and be replaced by the thinner and lighter liquid.

In the anode compartment must be placed a saturated solution of sodium sulphide Na_2S; in the cathodic division a diluted solution of soda.

Thus made up the electrolyzer constitutes an element which may be multiplied as often as required to produce the desired quantity of antimony; these elements may be grouped either in series or in parallel by the aid of suitable connections in a manner to make the best use of the source of the current. The anode is furnished with a cavity or hollow, which is filled with mercury, in which a staple soldered to the copper cathode is inserted. The battery is mounted upon skids, with oil insulators, while the skids are insulated with glass.

We have seen that in the course of the electrolysis the sodium sulphide for the most part acts only as a solvent; it should not become exhausted. Meanwhile, it changes in time by contact with the air (though the passage of the current seems to retard this change somewhat), by the foreign substances introduced during the manipulation, etc. It is sufficient to remark that, as is always the case with concentrated solutions, a slight evaporation will allow of the recovery by crystallization of the major part of the product.

As was intimated above, the mother-lyes are retained for the possible extraction from them of the precious metals which they are almost sure to contain. When the deposit of antimony is deemed sufficient the cathodes are withdrawn and placed upon a little car running beside the batteries and taken to the melting furnace.

It is to be understood that the melting has no chemical significance; it is simply to run the metal in molds, in the usual ingots, to place it upon the market.—La Revue des Produits Chimiques.

ELECTRIC PECULIARITIES OF THE DIAMOND.

SPECIFIC gravity, hardness, and quantitative composition with oxygen have hitherto been held as the necessary requisites for the certain identification of the peculiar properties of the diamond.

Very recently a Mr. A. Artoin, of Turin, proposed that a number of electric phenomena, of which some appear quite characteristic, be added to the distinguishing features above referred to, as in a measure complementary and of equal importance.

The specific electrical resistance of the diamond is about the same as that of ordinary glass; it lies, according to the values calculated by Artoin, somewhere between 0.2 and 1.3×10^{13}.

Worthy of note is it, that graphite, the allotropic form of carbon, in which the diamond is transformed under very high temperatures, possesses 10^{15} times as great a conductivity. Subjected to the Roentgen rays, the conductivity of the diamond is increased twofold, only to be reduced to its original capacity immediately upon the removal of the beam. Like ice the diamond also possesses a dielectric constant, which is much greater than would be expected from its exponent of refraction (relatively here, the dielectric constant K = the square of the exponent of refraction N^2). Theoretically, it ought to be 7; in reality, however, it lies somewhere between 10 and 17. This may be taken to indicate that the diamond, as is the case with ice, retains the dielectric constant of a former fluid state after it has become solidified. Meanwhile, it is possible that certain hydrocarbons, such as CH_2 and CH_3, are present in small quantities in the diamond, and to them is ascribable the augmentation in the dielectric constant.

The diamond, too, discloses a certain amount of permanent polarization and electric hysteresis. Besides, it is very weakly para-magnetic and pyro-electric.—Journal der Goldschmiede-Kunst.

AN UNUSUAL FORM OF CAPILLARY ELECTROMETER.*

By EMILE GUARINI.

MR. S. W. T. SMITH, Demonstrator in Physics at the Royal College of Science, London, has devised and had constructed an unusual form of the electrometer, the principle of which was applied for the first time in the Lippman electrometer, in which the superficial tension at the surface of contact of the mercury and diluted acid is modified when an electric current is passed through the surface that separates the two liquids.

In the construction of his apparatus the inventor

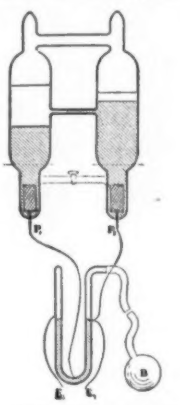


FIG. 1.—DIAGRAM OF THE CAPILLARY ELECTROMETER.

has endeavored so to arrange it as to obtain great sensitiveness in the measurement of the difference of potential, and to avoid such inconveniences as imperfect contacts, thermo-electric effects, vibrations of the meniscus due to the spring key, difficulties in using, etc., inherent to the old form of the capillary electrometer. In order to prevent the evaporation of the solution of sulphuric acid without interfering with the free motion of the liquids inside of the apparatus, the large tubes are closed at the top (Fig. 1) and connected by a transverse tube. The apparatus may be easily exhausted of air. The capillary tube extends from the center of one of the large tubes to the center of the other. The quantity of mercury is nearly sufficient to fill one of the tubes, and that of the solution, to fill half of it. The distribution of the mercury may be varied by means of a transverse tube provided with a cock and placed at the bottom of the apparatus; but this is not indispensable. The electrodes, P^1, P^2, consist of small plates of platinum, and may, without inconvenience, be moistened by the acid solution.

The usual spring key is replaced by a U-shaped tube closed at one extremity and communicating through the other with a rubber bulb. In the curve of the U-shaped tube there is some mercury. Three platinum wires are inserted in the tube, as may be seen in the figure. Upon pressing the bulb, B, the same change of contact is produced as in employing a spring key.

Fig. 2 gives a view of the apparatus reproduced from a photograph. The extremity of the thread of mer-

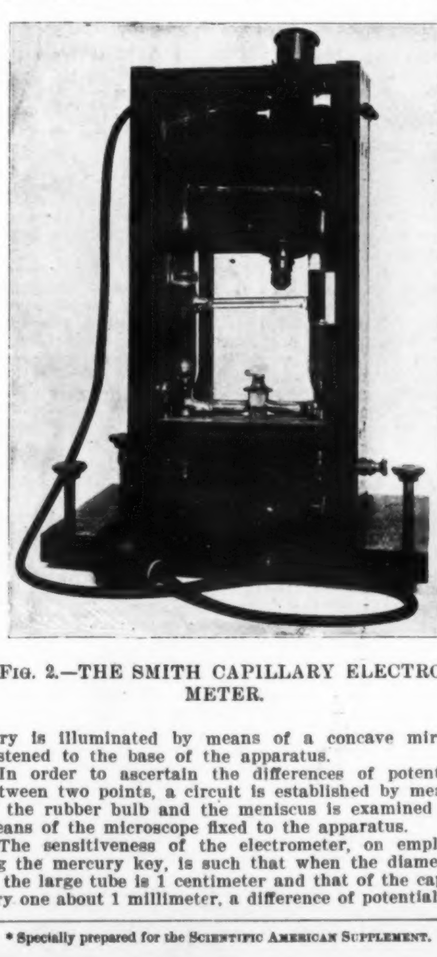


FIG. 2.—THE SMITH CAPILLARY ELECTROMETER.

cury is illuminated by means of a concave mirror fastened to the base of the apparatus.

In order to ascertain the differences of potential between two points, a circuit is established by means of the rubber bulb and the meniscus is examined by means of the microscope fixed to the apparatus.

The sensitiveness of the electrometer, on employing the mercury key, is such that when the diameter of the large tube is 1 centimeter and that of the capillary one about 1 millimeter, a difference of potential of 0.0001 volt suffices to produce a perceptible displacement in the meniscus, which can be noted with certainty with a microscopic enlargement of 100 diameters. The real extent of the motion is sometimes variable and amounts to about 0.01 millimeter. The sensitiveness of 0.0001 volt is sufficient for many measurements. The electrometer is for this purpose more practical than a galvanometer with a suspended magnetic system. It is more easily mounted than the galvanometer, and there are no lamp suspensions, no spark, and, so to speak, no leveling. The apparatus can, without inconvenience, be placed in various positions for transporting. Besides, the contacts of the key are not directly exposed to the atmosphere of the laboratory, and the thermo-electric effects are minimum, since the changes of contact take place between the mercury and the platinum, which are almost identically thermo-electrical. The heat imparted to the key by the hand of the operator is negligible, and that produced by the compression of the air in the key can be but minimum. The key may be fixed upon the rest of the apparatus, because the pressure is never but a few grammes, while with the spring key it is 500 and over. The microscopic examination likewise can be more attentively done. The potential at E must never be less than a few tenths of a volt, or more than 1 volt at E^2.

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

A CONTRIBUTION TO THE THEORY OF LIGHTNING RODS.

IN most lightning rods, round copper wires are used. Flat iron is also employed occasionally. In a paper recently published in the Elektrotechnischer Anzeiger, A. Schortau suggests the substitution of flat iron for copper wires, experiments made in the laboratory of the author having proven that lightning-rod circuits of flat iron insure greater safety than those of round copper. This may be demonstrated in a theoretical way as follows:

According to Faraday, electrified bodies are wholly analogous in their behavior to condensers and Leyden jars. Federsen has shown by photographical means that disruptive discharges are of an oscillatory nature. The photographs taken by him give evidence of the regular variations in the luminous intensity, resulting in a reciprocating movement of electricity and a gradual vanishing of the intensity of the single sparks, whereas these phenomena as an entirety are presented to our eyes in the form of a single spark vanishing rapidly. Lightning, accordingly, may be considered as the oscillatory discharge of a condenser, the dielectric of which is the atmospheric air, whereas the clouds and earth will act as armature. These oscillatory discharges hence constitute alternating currents of infinitely small periods and infinitely high frequencies, these frequencies being designated in the following by the letter n.

According to Poynting's theory, high-frequency alternating currents are propagated only at the surface of a conductor, the current diminishing from the surface toward the interior of the conductor, resulting in an apparent augmentation of the resistance of the latter. This apparent resistance, termed *skin effect*, is calculated by means of the formula

$$R = W\sqrt{\pi\, n\, l\, \mu\, q}$$

where W is the ohmic resistance, n the frequency, l the length, μ the permeability, and q the cross section of the conductor. Hence it is inferred that the apparent resistance will increase as the square root of the frequency. The condensation of high-frequency currents on the external portions of a conductor is observed with a particularly high intensity in the case of magnetical metals and especially for very low frequencies. This condensation, as determined by J. J. Tomsen, decreases from the surface toward the central part inversely as the square roots of the surface. This diminution for any point distant from the surface, in the interior of the conductor, is

$$F = 2\pi\sqrt{\frac{u\, n}{c}}$$

where μ is the permeability, n the frequency, and c the specific resistance. This shows that alternating currents of an infinitely high frequency are capable of penetrating into the conductor only for a small fraction of a millimeter. The specific resistance therefore plays a rather unimportant part, c being small as compared with n. In order to diminish the condensation of high-frequency alternating currents on the surface of the conductor, the latter should have the form of broad metallic ribbons, possessing the advantage of a greater surface. An additional advantage results from the inductance being diminished in the case of similar metallic strips. M. Wien showed as far back as 1894 that a strip of sheet metal offers a much lower inductance than a round wire of equal length and cross-section. The following table gives some of his results:

Breadth of strip.	Inductance of zinc strip. Measured.	Inductance of zinc strip. Calculated.	Inductance. of wire.
11.5 mm.	483 8 cm.	488 9 cm.	568.9 cm.
21.5 mm.	428.5 cm.	430.2 cm.	535.5 cm.

From the above evidence is shown that the substance lightning rod circuits are made of, is of no material importance, the geometrical form of the conductor determining the qualities of the circuit, and the most practical form being constituted by thin flat iron bars such as found in trade in the form of pieces 50 inches in length. The *skin effect* is thus best utilized, and the inductance lowered to a noticeable degree.

As both the inductance and ohmic resistance should be a minimum and the surface a maximum, and as, on the other hand, the ohmic resistance is always much smaller than both the apparent resistance and the inductance, the author suggests testing lightning rods by making determinations of the inductance in addition to readings of the resistance as now exclusively made. In order to insure a contact as perfect as possible, strong tinfoil should be interposed between any two contact surfaces. The use of flat iron rods offers the additional advantage of being more economical than copper wire, and of being more easily and more rapidly fixed and mounted.—A. G.

ARTIFICIAL SILK MANUFACTURE IN GERMANY.

A PLANT erected near Sydowsaue, Germany, is at present turning out 50 pounds of skein silk a day, which product can be increased in quantity to 2,000 pounds. The silk is soft in texture and creamy in color. Each thread is made up of eighteen single strands; a single strand is hardly perceptible to the naked eye. In strength, it is but one-third that of the real silk. When woven into pieces the new substitute is said to have the appearance of real silk. How this new article will compare with the genuine, in the matter of wear and price, it is impossible at present to state. The manufacturing process is likewise undiscoverable. It is asserted, however, that the pulp undergoes a chemical process and is pressed through very fine tubes, by hydraulic pressure, forming the single strands which go to make up the thread.

AUSTRALIAN SPONGES.

ALTHOUGH the existence of various kinds of sponge on the Australian coast has been known for many years, the possibility of cultivating those descriptions possessing a commercial value has only recently attracted attention. It appears that in August, 1900, the trustees of the Australian Museum, in Sydney, received from the New South Wales Fisheries Commissioners a donation of a large collection of sponges obtained by their inspectors stationed on the seaboard of the state, the object being to ascertain the number of species suitable for commercial purposes, or that might be rendered such by cultivation. The work of investigation was intrusted to Mr. Thomas Whitelegge, the Museum zoologist, who devoted considerable time to the work of classifying the collection, consisting of about six hundred and thirty specimens, of which forty belonged to the commercial kinds, seven being regarded as possessing an economic value. The result was to show that at least eight species and varieties of sponge, having a commercial value, were indigenous to the New South Wales coast, and that it was probable a systematic investigation would prove the existence of other kinds of equal or superior commercial value. Many of the specimens had been washed ashore during heavy gales, while others were water-worn or dried up. Several kinds were obtained from Sydney Harbor. The living sponge has been seldom met with, but during some fierce gales in 1901 the heavy seas cast on the harbor and ocean beaches an enormous amount of marine products. Seaweed was piled up to the depth of three or four feet, and with it a vast quantity of animal life. Several of the heaps, composed of the smaller organisms, were simply large, brilliantly variegated mounds, containing representatives of the New South Wales marine fauna and flora. In addition to the large and varied accumulation of seaweeds, the beaches were strewn with fish, mollusks, crustacea, worms, alcyonareans, echinoderms, zoophytes, ascidians, and sponges, the two latter being the most abundant. The beaches in some places were carpeted with organisms resplendent with all the colors of the rainbow. Here Mr. Whitelegge was enabled to secure numerous living specimens of sponge, and found them beautifully colored—reddish orange, dark terra cotta, madder brown, dark yellowish stone, orange buff, yellowish cream, and pale cream. The tints changed after death, one kind, a canary color, becoming bright purple. Among the commercial sponges, a new species, the *Euspongia illawarra*, is declared to be "quite equal" if not superior to many of the kinds used for domestic purposes. Mr. Whitelegge found the dried skeleton soft and extremely elastic; when wet it was tough, elastic, and apparently very durable. In color it is a light yellowish brown. The main fibers are entirely free from foreign bodies such as sand grains and spicule fragments, which are present in nearly all the sponges purchasable in Sydney. In fact, it may be said that all sponges, economic and non-economic, so far examined, have foreign bodies in their composition, but the *Euspongia illawarra* is superior to all previously known in this respect. To use Mr. Whitelegge's own words, "This sponge is by far the best occurring on the coast, and is equal if not superior to many of the commercial sponges procurable in Sydney." The discovery that sponges of commercial value are abundant on the New South Wales coast has raised the question of their systematic cultivation, and here it has been ascertained that it can be readily propagated, as on the coast of Florida, by placing small living cuttings in suitable places. The most favorable location seems to be anywhere within the bays and lagoons free from heavy seas, too strong currents, and too much fresh water; and in moderate depths for easy handling and observation. The growth is faster in strong currents, but in such a case the shape is apt to be poor and the quality harsh. Under favorable conditions the cuttings double their size in six months, consequently eighteen months to two years will produce marketable sponges. The growth is naturally regulated largely by local conditions, such as temperature, food supply, and situation; and Mr. Whitelegge advises that "after fixation the material with the attached sponge could be transported to places calculated to encourage rapid growth." His own experience teaches him that "the finest specimens of sponges . . . are generally found suspended under stones or from the roofs of caves. Under such conditions they are shaded from excessive light and possibly have a more abundant food supply, or the inverted position gives the sponge a better chance of obtaining food."—Journal of the Society of Arts.

Hard iron castings may be softened by the following process, according to the Deutsche Schlosser Zeitung. The entire casting is brought to a red heat and then slowly cooled while covered with carbon dust. If the castings to be softened are small, a number of them are packed into a crucible and materials are added which at red heat give off carbon to the iron. The crucible is carefully closed and is gradually heated and kept for a couple of hours in a furnace or an open fire, and then also slowly cooled. Suitable materials for supplying the carbon are cast-iron lathe chips or soda.

ENGINEERING NOTES.

A new field forge for the United States army, equipped with horseshoer's, saddler's, carpenter's and blacksmith's outfits complete, has been constructed in New York. It is a motor car, and is 12½ feet long. The engine is of the four-cylinder type and 24 horse power. The gasoline tank contains a supply sufficient to propel the machine 300 miles. It has a maximum speed of 10 miles an hour. An auxiliary engine on one side of the machine operates the dynamo, lathe, and also a grindstone for sharpening tools.

Three thousand seven hundred and eight vessels, or a total tonnage of 11,248,000, passed through the Suez Canal in 1902, as compared with 3,699 vessels of 10,824,000 tons in 1901, showing an increase of nine vessels and 424,000 tons. Of these 3,708 vessels, 2,733 were merchant cargo vessels, 822 mail steamers, and 153 warships and transports. In spite of the increase in number and in size of vessels, the mean duration of passage has been reduced from 18 hours 41 minutes in 1901 to 18 hours 2 minutes in 1902. The general effective rate of transit for mail steamers is 15 hours 40 minutes.

The ferryboats connecting Warnemünde, Germany, with Gjedser, Denmark, have just been completed, and the regular service was opened some days ago. The boats are fitted with all the accommodations of modern steamships, and are to be remarkable for their steady sailing. The journey from the Continent to Scandinavia by the above route will henceforth be made by rail only, as these ferryboats are intended to take the whole of the train and to transport it from one shore to the other, being a voyage of two hours. In addition to the increased convenience afforded by this ferryboat service, the journey will be considerably shortened.

In a paper recently read in Düsseldorf, W. Mathesius suggests utilizing thermite to obtain dense castings (i. e., free from pores) from gray iron and steel. The effect of thermite on the metal to be cast is threefold: The metal disengaged from the thermite during the combustion is alloyed to the bath at the moment of its production; the bath absorbs heat from the heat of reaction, and finally a violent intermixing of the bath takes place. The combination of thermite takes place without any supply of gases and without the formation of any gaseous products in the reaction. The perforated sheet-metal box where thermite is generally burnt, is in the case of gray iron slipped centrically on a dry iron bar free from rust, and afterward, after being preheated by the hand to moderate temperature of the hand, is introduced into the liquid metal placed in the casting crucible, until the reaction is completed after 1 to 1½ minutes. This process gives castings of much finer structure and capable of taking high polish, on account of the finely-divided graphite. The supply of heat will, in the case of sufficiently high quantities, exceed the heat losses by radiation. The metal, after the reaction, is perfectly free from gases. The thermite to be used in connection with gray iron is titanium thermite, containing titanium oxide along with iron oxide. Titanium is capable of binding nitrogen in the hot liquid cast iron, if present even in small percentages. The liquid casting is thus enabled to compensate the noxious influence of the air accumulating during the casting process, the nitrogen of air being bound in the form of titanium cyanide, and the iron monoxide formed by the atmospheric oxygen dissolved in the liquid. The strength of the iron in itself is but little increased by the thermite treatment, which, however, enables hard or soft castings to be produced by adding ferro-manganese or ferro-silicium to the casting.

The Foreign Office has issued a report from the Consul-General at San Francisco, in which he states that a new demand has sprung up for redwood, a material which California alone can supply. It has been discovered by the chief engineer of the Niagara Falls Power Company that, under certain conditions which rule in connection with that industry, the hardest steel is inferior in resisting power to California redwood. The company sent an agent here to obtain figures for furnishing several million feet of the local lumber for one of the great tunnels at Niagara Falls. It appears that the engineer-in-chief of the Niagara Falls Power Company had recommended that redwood should be employed instead of steel for a great tunnel to be constructed this summer. The reason given for the preference for the California wood was that when water passed over it continuously there formed a surface of soapy and pasty nature which was proof against corrosion, whereas in the case of steel the particles of sand and matter carried with great velocity from the Niagara River cut into and destroyed the steel in an incredibly short space of time. The Redwood Association was asked if it could furnish 3,000,000 feet of redwood for delivery in Buffalo in July next, and gave an affirmative reply. The redwood lumber to be supplied for the Niagara power tunnel is to be 3 inches by 8 inches, and to be set on the narrow end, the length to be from 12 feet to 20 feet. Redwood has been found exceedingly useful in the construction of the big pipes used for the conveyance of water to many of the electric-power houses in the northern part of the State. These pipes are built up and banded. They cost less than metal pipes, are more durable, and are more easily carried around the sharp curves followed by these great water lines. It will outlive all other woods when kept constantly moist. While it is not non-combustible, which quality some enthusiasts have erroneously ascribed to it, it burns much more slowly than any other kind of timber used for building purposes, as it contains no inflammable oil or resin. While it is not desirable to be used as a fire wall, the resistance it offers to the inroads of fire has been the salvation of many dwellings constructed with it. The discarded stumps of redwood felled for their lumber many years since have come into favor for the manufacture of furniture and the interior decorations of buildings, the curled grain making beautiful figures, and the wood itself taking a fine polish. Just at present California redwood is in great demand in the Eastern States of America.—Building News.

ELECTRICAL NOTES.

A new system invented by two Alsatians for the transmission of electrical impulses without wires through the earth consists in both poles of an electric-current conductor being connected to the earth, whereby an electrical induction field is set up around each pole, the extent of which depends on the intensity of the current employed. In each of these two induction fields it is possible to utilize the electrical impulses produced at the place of generation by the introduction of two poles at suitable points within one of these fields. Relays, such as are well known in telegraphy and telephony, may be employed in order to transmit the electrical impulses over a wider area, these being connected to the two poles and their resulting currents being used to generate further fields. The inventors claim to transmit by means of their system telegraphic, telephonic, or any other desired electrical impulses, the transmission not being subject to outside influences, such as bad weather, storms, etc.—factors which render the wireless transmission of electrical impulses through the air more or less unreliable.

The production of aluminium in the United States during 1902 was approximately 7,300,000 pounds, as compared with 7,150,000 pounds in 1901, an increase of 150,000 pounds according to a report on the production of that metal by the United States Geological Survey. The Pittsburg Reduction Company, operating the Hall patents, continues to be the sole producer of aluminium in the United States, and, although the company is in patent litigation with the Cowles Electric and Smelting Aluminium Company, of Cleveland, its plants are being developed vigorously. It has in operation 11,000 horse power at Niagara Falls, N. Y. and 5,000 horse power at Shawinigan Falls, Quebec, a total of 16,000 horse power which is equivalent to a capacity of 4,500 tons of metal yearly, or more than the entire output of the rest of the world. The increased activity on the part of the company has been due to the fact that some of its fundamental patents will expire within a few years, and it is striving to perfect the methods employed to such an extent that after the expiration of the patents it will be in a position to compete successfully with new producers that may enter the field. Although the demand for aluminium has increased extensively, the price per pound continued practically stationary throughout the years 1901 and 1902. An international agreement between all of the aluminium producers has been drawn up and the price of ingot aluminium fixed for 1903, says the report. There are five companies in the world that produce aluminium at nine locations. For several years past the various companies have continued their secretive policy concerning the development of the industry, and practically nothing has been published in regard to modern improvements beyond the descriptions of patents, which have been granted mainly for the purification of bauxite—the chief raw material used in the manufacture of the metal.

According to Crookes, electrons emanating from radioactive bodies behave like material particles, and are impeded by the molecules of the surrounding medium, in contrast with ether waves, which are not thus affected, except by absorption. Crookes describes experiments in proof of this statement. Actinium (which he incidentally states to be identical with the body which he called Uranium X in his Royal Society paper of May 10, 1900) and radium give electrons which partake of the properties of a fog or mist of material particles capable, when not kept in by a thick metal screen, of diffusing away in the free air like odoriferous particles, but the behavior of polonium is different as regards this diffusibility. Radium emanation may be carried away by a current of air passing over the metal. It will also pass through aluminium and a considerable length of air, and then affect a sensitive film, but experiments on this point with polonium show that air offers great obstruction to penetration by its emanation. Strutt has suggested that while the penetrating deflectable Becquerel rays are generally recognized as consisting of a stream of negative corpuscles with high velocities, the non-deflectable and absorbable rays are positive ions moving in a stream from the radio-active body. On this hypothesis, corpuscles from polonium might consist of heavy positive ions, and Crookes is now making experiments to test the accuracy of this inference. Crookes has shown in a previous paper that many bodies, such as silver, gold, platinum, etc., usually considered non-volatile at ordinary temperatures, easily volatilize in a vacuum if connected with the negative pole of an induction coil, but remain fixed when connected with the positive pole. When a silver pole was used in a tube of very high vacuum ($P = 0.00068$ mm.), and a sheet of mica, with a hole in its center, placed in front of it, then when the poles were connected with the coil, the silver being negative, electrons shot from it in all directions, and, passing through the hole in the mica screen, formed a bright phosphorescent patch on the opposite side of the tube. After continued action of the coil for some hours it was found that silver had been deposited only on the mica screen and in the immediate neighborhood of the pole, while the far end of the tube, which had been kept glowing for hours from the impact of electrons, was free of silver deposit. Accepting Strutt's view that positive as well as negative corpuscles will fly off from a radio-active body, we have here two simultaneous actions. Electrons were shot off from the negative pole, and caused the glass on which they impinged to glow with phosphorescent light. Simultaneously, the heavy positive ions of silver, freed from their negative electrons, or under the influence of electrical stress, also flew off, and were deposited in the metallic state near the pole. Experiments were made to see whether these metallic ions, thus deposited on a metal plate connected to an idle pole, in the full stream of + ions and — electrons, showed any special + or — electrification. In all cases the electrification was positive, thus lending support to the view of Strutt, although this result must not be taken as conclusive, for the author has previously shown that, at a high vacuum, nearly the whole of the interior of a tube through which an induction spark is passing is electrified positively.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Hints for Exporters to the Philippines.—The August number of the Chamber of Commerce Journal, of London, England, says:

Exporters of goods to the Philippines would do well to take careful note of the following hints as to the formalities to be observed in trading with these islands:

Catalogues.—Catalogues, which should be submitted in Spanish, should always contain the telegraphic address and the telegraphic codes in use. As correspondence with the Philippine Islands necessitates a very long delay, it often happens that exporters are obliged to cable; hence the application of a code to all the articles offered is an economy which should not be disregarded. Another important point is the quotation of prices for catalogued goods, otherwise the catalogues are of no more value than a book of illustrations. The weights and measurements of the articles shipped, as in customary packages, should also be given.

Packing and marks on packages.—Special care is needed in packing. The port is completely without protection and the bay is 30 miles in diameter. The sea is often—at least from June to October—so rough that all discharging operations are impossible; transshipment is carried on 2 miles from the shore, in native cargo boats, tossed about by the least agitation of the waters. Fortunately, the recent acquisition of large steel tenders has to a certain extent lessened this danger. In a short time boats will be able to ride and discharge directly in an artificial roadstead. In the meantime it is essential that goods should be packed very carefully. Each package should have clearly marked upon it the name of the consignee and its particular mark. It should also always bear an indication of its gross and net weight in pounds and kilogrammes, and also its cubical contents.

Invoices and other documents.—It is not possible to emphasize too clearly the necessity of the correct drawing up of the invoices. The following are extracts from the Philippine customs laws: (1) Each parcel must be enumerated in the invoice with its marks and numbers; (2) the contents of each package should be shown in detail, with the sale price and place of destination; (3) if the contents of a package fall under two separate classifications the weights of each component part of the package should be shown in the invoice and not the total weight (it would, in fact, be impossible for the customs officers to open hundreds of packages to classify the contents, weigh them, and estimate the duty); (4) the declared weights should include that of the box or papers which contain the articles (in fact the interior packing is not deducted, but pays the same duty as its contents); (5) exterior packing, such as cases, barrels, etc., is deducted, also the net tare and gross weight should be shown on the invoice as also on the package itself; (6) invoices should always be submitted in triplicate, two for the customs and one for the consignee. Manufacturers should choose as agents in the Philippine Islands persons of great experience. The customs officers at Manila are guided by fixed rules sanctioned by law and from which they are not able to depart. Exporters should apply themselves to these rules, otherwise great inconvenience both to themselves and the customs officers will be entailed. It is recommended that they should carefully study in the Philippine tariffs the separate classifications and draw up their documents in accordance therewith. Manufacturers should avoid putting small samples in their shipments, or else state clearly in the documents that they are such, otherwise importers would probably be obliged to pay duty on these articles and perhaps also a fine.

Bills of lading and insurance.—The exporter should send by first mail after shipment of the goods a second bill of lading, in order that the importer may be informed before the arrival of the boats as to the details of freight. It is preferable to insure with companies having an authorized representative at Manila, of which there are several.

Commercial travelers in the islands of the Philippine Archipelago must, says the Bulletin of the Paris Chamber of Commerce, pay a tax of $150 Mexican per annum. This tax must be paid quarterly in advance. They have, besides, to take out a license in the town of Manila, costing $20 in gold annually, which must also be paid in advance. The samples which accompany commercial travelers are subject to the customs duties pertaining to the goods which they represent. When, however, their value is below $2,000 gold, the duty levied on their entry is reimbursed on their exportation, provided that this is effected at the customs entry office within three months, or six months at the latest. In the latter case the commercial traveler must, before the expiration of the first three months, obtain from the chief of the customs a prolongation of three months. In order to obtain the reimbursement in question the commercial traveler is bound to present the samples at the customs at least five working days before the date of re-exportation, so that they may be identified. When the value of the samples exceeds $2,000 gold, the duty levied on the excess belongs definitely to the treasury, but the commercial traveler may, at the entry, select the samples on which an allowance of the duty is eventually to be made to him. Before the samples are permitted to enter on the terms specified above, the commercial traveler must take the oath required for the free entry of foreign merchandise, and he must, equally upon oath, make a declaration in accordance with article 220 of the customs laws.

Tahitian Vanilla Beans in the American Market.—The explanation for the decrease in the exports of vanilla beans from Tahiti to the United States is due to the fact that the demand for this grade is almost at a minimum in the markets of San Francisco and New York. The price at the former place has recently declined to 40 cents per pound. At this rate the merchants exporting vanilla from Tahiti simply have the advantage of a medium of exchange for goods imported from San Francisco. It means the avoidance of chasing a money order—a slight consideration. It also is of service to the merchants to handle vanilla here, in view of the difficulty of forcing payment on the part of creditors who are the traders for the large establishments. The traders who are generally slow in remittances can turn over vanilla beans, as a rule on account. The small trade is generally in the hands of Chinamen, and they encourage trade with the natives by accepting options on the vanilla output, and ultimately receive the beans in the crudest form, and proceed to cure them. There can be no doubt that the curing methods employed by these small traders are defective, and therefore the Tahiti bean has steadily declined in the estimation of importers in San Francisco and New York. Knowing that the very name now is sufficient to condemn the vanilla exported from this colony, I endeavored to enlist the interest of the officials here to a plan for compulsory inspection and grading under seal, under the control of the government. The matter, however, has not been regarded in a favorable light by the officials, although it has appealed to many planters and merchants. It is possibly my duty, although an unpleasant task, to state for the benefit of importers of vanilla beans from Tahiti that they should be very careful to examine closely any beans that they have reason to suspect have been cured by Chinamen here. To my knowledge the Chinese traders are accustomed to pick up beans cast away by others as utterly unfit for market, soak them in salt water, or let them remain for a time in cocoanut oil, and then pack them in the bottoms of tins containing better grades. Chinamen will buy even moldy vanilla beans, and so scatter the bad ones among good ones as to avoid ordinary scrutiny.

It is a far pleasanter task to relate that there are a few large companies, composed mostly of native planters, that are trying to put a high grade of vanilla bean on the market. No doubt later the importers in the United States will appreciate their efforts and reward them. It would be well if these planters would label their articles by a special brand, and thus give guaranty as to quality.—William F. Doty, Consul at Tahiti.

South African Coal Fields.—Under date of July 14, 1903, Consul W. Stanley Hollis, or Lourenço Marquez, states that according to the Gold Fields News, Barberton, July 10, 1903, the Komati Poort coal area would be declared open during the month. The boundaries of this field are wide and are roughly as follows: On the north, the Crocodile River; on the south, the Swaziland boundary; on the east, the Portuguese line; and on the west, the limits of the proclaimed area of the Kaap gold fields. Although the extent of the coal deposits is not yet clearly defined, it is believed to be a continuation of the coal belt which proved to be valuable on the borders of German East Africa and the Portuguese territory, and extends southward to Natal and even farther. This contention is borne out by the knowledge that the Swaziland and Zululand outcrops are on the same line of country. As far as yet made public, the deposits at Komati Poort show evidences of three or more distinct geological periods. In one bore hole, opened not so very long ago, the strata pierced were in the following order: Sandstone, shale, coal, a 6-inch seam of shale, then coal again, with shale and sandstone beneath. There the exploration stopped for the time, but the occurrences of the seams certainly are favorable to the belief that an extensive coal field is there, and that only the opportunity which is now to be given by the government has been the cause of the bounties of nature not having been sooner drawn upon in this locality. Certain Delagoa men are keenly alive to the possibilities lying dormant here and the encouragement offered to exploration work in a district so adjacent to a seaport, where facilities for loading coal will shortly be provided on a scale not hitherto seen on this littoral.

Hints for the Export of Leather Goods.—The following is taken from the August number of the Chamber of Commerce Journal, of London, England:

Machinery belting in Servia under the classification "saddlery and gloves and other goods not specially enumerated," had hitherto to pay an import duty of 100 dinars ($19.30) per 100 kilogrammes (220 pounds). In accordance with a decree issued at the end of January of the present year, it may now be imported as "machinery and parts of machinery," free from duty, if imported by manufacturers for their own use. The French consul at Lima reports that of foot gear Peru imports especially ladies' shoes. Men's shoes are mostly made in the country. Leather gloves do not meet with a large sale, as cotton and silk thread gloves are principally worn. Saddlery is almost exclusively supplied by England, whence also the largest part of the driving straps is imported. The German consul at Rio de Janeiro says the total importation of leather, hides, and goods made therefrom into Brazil amounted during the first eleven months of 1901 to 4,379,000 milreis* ($2,392,934), of which France sent 1,950,000 milreis ($1,056,000) and Germany 1,372,000 milreis ($749,112), while Great Britain and the United States appear only with the import values of 422,000 and 402,000 milreis ($230,412 and $219,492). Almost nine-tenths of this importation consisted of leather and hides; of goods of this class only the value of 453,000 milreis ($247,338) was imported, principally from France, Germany, and to a small extent Great Britain. The import duty on hides and skins amounts, with few exceptions, to 30 per cent on the value; only for lacquered leather the charge is 60 per cent. This charge is almost without exception made on leather goods.

Tahiti Copra for the United States.—Copra is the most important export from the colony to the "States." It is gratifying that the latter received during the fiscal year ended June 30, 1903, a quantity valued at $201 891.43, which is slightly more than double the value of that exported during the preceding year. The blight on the cocoanut trees remains in some of the Society Islands, but has passed for the most part from Tahiti, the largest one of the group. It is to be regretted that a large quantity of copra goes to European ports by sailing vessels, under long charter, that bring goods from France to this place. The importers in San Francisco probably could secure this foreign consignment by making arrangements with the leading merchants here, extending over long periods of time. It is to be said that the best way for importers in San Francisco to secure the copra would be to organize a company and lease or buy large tracts in these islands and become producers. The labor problem could be solved by paying living wages to natives, and, further, by importing coolie labor. There is a fine opportunity for American capital to own the best land for cocoanut culture. Land in this colony can be had, but it requires, generally, a negotiation that extends over three or four months. Probably the finest tract for a large cocoanut plantation is that situated on the island of Moorea, which is 12 miles distant from Tahiti. The tract is a large valley called "Opunohu," containing 3,000 acres of soil adapted for the culture of cocoanuts, cotton, sugar, coffee, and probably other tropical plants of commerce. The price ($20,000 gold) is very reasonable. To clear and develop and plant 150,000 cocoanut trees, in the course of three or four years, there would have to be an expenditure of possibly $50,000 to $75,000 additional. The plantation, after seven years, would begin to bear, and doubtless continue to do so, in the ordinary course of events, for very nearly a century. To invest in land here would seem to be warranted by the proposal of the government of the United States to build an isthmian canal next to the Galapagos Group. The French possessions excel other clusters in favorable situation for commerce.—William F. Doty, Consul at Tahiti.

Business Opportunities in Paraguay.—I desire to call the attention of capitalists and those engaged in commercial enterprises in the United States to the new financial law recently passed by the Paraguayan Congress and promulgated yesterday by the President of the Republic. The authorities having charge of the expropriation of half the hides for exportation, which will amount to about 125,000, will entertain bids from various sources on these hides. I would suggest to the dealers and importers in hides that from what I can gather the most advantageous bids would embrace the price f. o. b. Asuncion. The number of hides may be larger than this calculation, because in 1891 the total number exported amounted to 238,495, and they are increasing every year. People who are interested in waterworks should also send in their bids. The government will negotiate a loan of $1,000,000 gold, and the number of hides expropriated by the government under this law will be offered in arranging the guaranty. Parties interested in hides should be prompt in bidding, for the reason that the President of the Republic is authorized at the expiration of three months to arrange the disposal of them.—John N. Ruffin, Consul at Asuncion.

Foreign Students at German Universities.—Of the 37,813 students who are at present matriculated at the 21 German universities, 35,082 are Germans and 2,731 foreigners, the latter being 7.2 per cent. of the total number. Of these foreigners, 2,299 belong to European and 432 to non-European countries. Russia is represented by 860; Austria-Hungary, 536; Switzerland, 253; Great Britain, 149; Bulgaria, 67; Roumania, 63; Greece, 56; Italy, 45; Netherlands and Servia, 45 each; France, 44; Turkey, 36; Sweden and Norway, 32; Luxemburg, 27; Belgium, 14; Spain, 11; Denmark, 10; Portugal, 3; Montenegro, 2; Lichtenstein, 1; America, 276; Asia (mostly from Japan), 133; Africa, 19; and Australia, 5. Of the foreigners, 628 study philosophy, 616 medicine, 588 mathematics and natural sciences, 351 law, 199 forestry, 146 agriculture, 124 Evangelical and 23 Catholic theology, 29 pharmacy, and 27 dentistry; 876 are matriculated at Berlin, 406 at Leipzig, 257 at Munich, 197 at Heidelberg, 146 at Halle, 128 at Freiburg, 99 at Goettingen, 79 at Jena, 75 at Königsberg, 67 at Bonn, 66 at Strassburg, 54 at Würzburg, 53 at Giessen, 51 at Marburg, 41 at Breslau, 37 at Greifswald, 30 at Tuebingen, 25 at Erlangen, 17 at Kiel, 14 at Rostock, and 13 at Münster.—Richard Guenther, Consul-General, Frankfort.

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* The milreis is reduced to United States currency at the United States Treasury valuation of the gold milreis, it being assumed that the German consul at Rio de Janeiro figured on that basis, and a comparison of the trade of Germany and France with Brazil bears out this assumption. While the gold milreis figures in official estimates, the depreciated paper milreis is the circulating medium of Brazil and that in which all business is transacted. The present value of the paper milreis may be accepted at 15 cents.

TRADE NOTES AND RECIPES.

Mourlot Fils' Substitute for Gutta-percha (French Gutta-percha).—The discovery of a good substitute for that expensive substance, gutta-percha, has long been a want in electrical circles. Such a substitute can be prepared in the following way: A decoction of birch bark, the external bark by preference, is evaporated. The thick, black residue hardens on exposure to the air, and is said to possess the properties of gutta-percha without developing any cracks. It can be mixed with 50 per cent of India rubber or gutta-percha. The compound is said to be cheap and a good non-conductor of electricity. Whether it possesses all the good qualities of gutta-percha must remain an open question for the present.

Driers.—As regards concentrated and liquid driers, Livache states in Les Corps Gras Industriels, 1903, p. 231, that concentrated siccatives are produced by heating linseed oil with 10 to 70 per cent of litharge, red lead, or manganese borate to 250 to 300 deg. C. In lieu of the above-named compounds, one may also employ lead acetate or zinc oxide. The concentrated driers thus obtained are thick, semi-liquid, brown masses and serve for the production of varnishes from linseed oil by the cold process.

Liquid driers are prepared in the same way, with the exception that they are diluted with turpentine oil after a short removal of the vessel from the fire and filtered.

Take, for instance:

Linseed oil	7 kilogrammes
Litharge	2 kilogrammes
Manganese dioxide	2 kilogrammes
Red lead	1 kilogramme
Oil-turpentine	14 kilogrammes

Or for white liquid drier:

Linseed oil	7 kilogrammes
Manganese borate	2 kilogrammes
Lead acetate	1½ kilogrammes
Oil-turpentine	13 kilogrammes

In boiling the latter kind, a white mass is obtained instead of a red one, which, however, slowly turns yellowish. For white paint the solid driers are preferred; in the case of other oil paints the admixture of a little liquid siccative causes very rapid drying.

Trials have also been made to manufacture driers by the cold process, e. g., by mixing 10 parts of finely powdered lead acetate with 120 parts of poppy-seed oil, which mixture is exposed to sunlight in a glass vessel, shaking frequently. The colorless oil obtained, after admixture of 25 parts of oil of turpentine, dries quickly, forming a firm coating.

If turpentine oil is simply agitated with powdered litharge and decanted, a constant liquid is obtained which gives a very resistive coating that will not crack off.

Treatment of Natural Wood, for Decoration.—The knowledge of the staining action of lime caused me to attempt not only to paint, but also to stencil on oak panels with white lime paint.

After the lime paint had dried slowly in the shade, I brushed it off and now had the satisfaction to see the decoration in a handsome dark-brown tone on the oakwood. Some portions which I desired darker and redder I stained again with lime, whereby these places became deeper. It is essential that the lime be applied in even thickness and dried slowly, for only then the staining will be red and uniform.

After the staining I saturated the wood with a mixture of varnish 2 parts, oil of turpentine 1 part, turpentine ½ part. When the oil ground was dry, two coatings of pale amber varnish were applied.

I also endeavored to produce colored decorations on pinewood, by treating the crude woodwork of a room. The most difficult part of the work was to remove the resin accumulations, without causing a spot to appear. I know of no other remedy than to burn out the places carefully with a red-hot iron. Great care was necessary to prevent the iron from being too hot and setting the resin on fire, thus causing black smoke clouds.

The resulting holes I filled up with plaster size to which I added a little light ocher, endeavoring to imitate the shade of the wood as perfectly as possible. I plastered up no more than was necessary.

Now I rubbed down with very fine sandpaper, taking especial care to rub only in the direction of the growth of the wood, since all cross scratches would have remained permanently visible on the soft wood, as is often the case with marks from the plane which a careless carpenter has produced by working across the grain.

After this preliminary work I covered the wood with a solution of white shellac, in order not to injure the handsome golden portions of the wood by the darker tone of the blond shellac, and to preserve the pure light tone of the wood in general.

On this shellac ground I painted and stenciled with glazing colors, ground with isinglass solution. The smaller, more delicate portions, such as flowers and figures, I simply worked out in wash style with water colors, permitting the tone of the wood to remain as the light, surrounding the whole with a black contour.

After this treatment the panels and decorated parts were twice varnished with dammar varnish. The friezes and pilaster strips I had glazed darker and set off with stripes; to varnish them I took amber varnish.

The style just mentioned does not exclude any other. Thus, for instance, a very good effect is produced by decorating the panels only with a black covering color or with black and transparent red (burnt sienna and a little carmine) after the fashion of boule work in rich ornaments, in such a way that the natural wood forms the main part and yet quite a considerable portion of the ornament.

Intarsia imitation is likewise well adapted, since the use of variegated covering colors is perfectly in place for the decoration of natural wood. How it should be applied, and how much of it, depends upon one's taste, as well as the purpose and kind of the object. The rule applying in this case, as well as in all performances of the painter, is: beauty and appropriateness.—Deutsche Drechsler Zeitung.

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